LA-17

SPECTRUM ANALYZER

OPERATION AND SERVICE MANUAL

Lavoie

ENTRON

MORGANVILLE, NEW JERSEY 07751

LA-17

SPECTRUM ANALYZER

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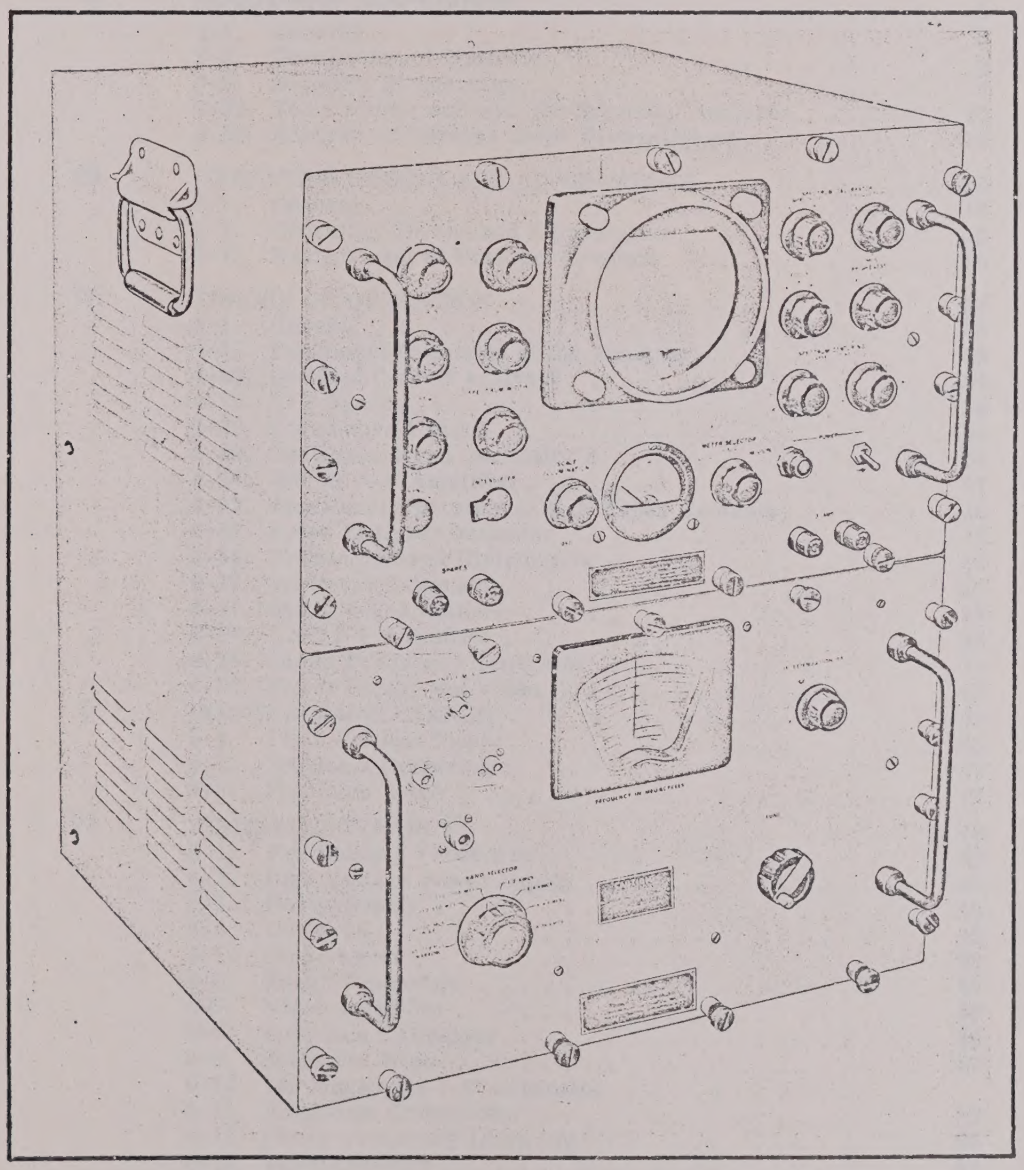
OPERATING AND SERVICE INSTRUCTIONS



Lavoie Laboratories, INC.

MICROWAVE EQUIPMENT

MORGANVILLE, NEW JERSEY

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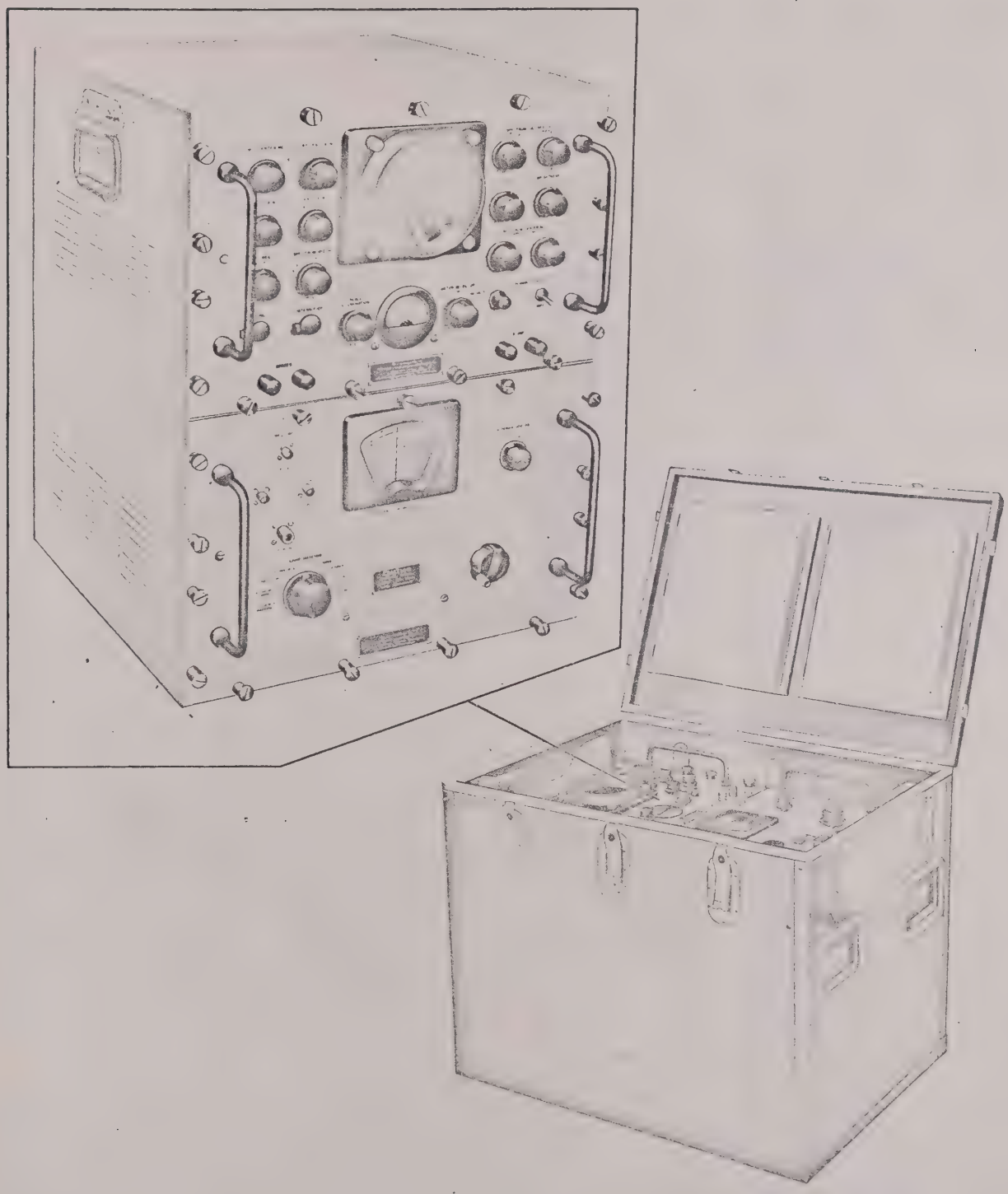


Figure 1-1. Spectrum Analyzer LA-17

SECTION I

GENERAL DESCRIPTION

1-1. PURPOSE OF HANDBOOK.

1-2. This handbook contains descriptive material and instructions on the operation of the Spectrum Analyzer, LA-17 (figure 1-1), manufactured by Lavoie Laboratories, Incorporated, Morganville, New Jersey

1-3. PURPOSE AND BASIC PRINCIPLES OF THE EQUIPMENT.

1-4. The spectrum analyzer is an electronic test instrument used to analyze the frequency spectrum and pulse shape of pulsed r-f oscillators employed in radar transmitters. The instrument can be used to check frequency modulation and frequency stability of an r-f oscillator as well as to measure the pulse and bandwidth of this r-f oscillator pulse. The analysis of pulse shapes is accomplished by viewing the pattern on the cathode-ray-tube screen of the analyzer. The pulse pattern represents the distribution in frequency of the r-f power of the pulse.

1-5. The spectrum analyzer is an instrument that incorporates a narrow-band superheterodyne receiver which is physically divided into two major components: The Pulse Analyzer Indicator and the R-F Tuner. The Pulse Analyzer Indicator is actually a complete spectrum analyzer which covers a frequency range from 145 to 175 megacycles. When the input frequency is 160 megacycles and the spectrum width is set at 10 megacycles, this unit possesses a sensitivity of approximately ten microvolts for a signal-to-noise ratio of two to one. The R-F Tuner is primarily a frequency converter which changes the frequency range of 10 to 16,000 megacycles to a basic frequency range of 145 to 175 megacycles. The converted signal from the tuner unit is fed to the indicator unit where it appears as a vertical signal on the baseline of the KRT. This baseline represents a frequency domain. The converted signal is that which is viewed (vertically) on the cathode-ray-tube screen on the panel of the indicator unit. The scope pattern produced is a plot indicating power vertically and frequency horizontally and represents the spectrum of an input signal to the Spectrum Analyzer.

1-6. To visually display the desired spectrum, the second local oscillator of the analyzer is swept in frequency while the horizontal deflection of the scope is varied in synchronism. For a pulsed input signal, a succession of transients appears on the screen which resembles a picket fence, and the envelope of the transients is proportional to the power spectrum. For ranges of frequency of the order of 0.5 to 25 megacycles, the horizontal deflection is accurately proportional to frequency. Figure 1-2 illustrates a one-microsecond rectangular pulse, having negligible frequency modulation, as it appears on the screen of the cathode ray tube. The illustration reveals the individual transients composing the spectrum.

1-7. DESCRIPTION OF UNITS.

1-8. GENERAL. The spectrum analyzer is designed to operate from a 115-volt, 50-1000 cps power supply. The power consumption is 250 watts, maximum. The instrument is capable of operating in the range of 10 to 16,000 megacycles. All frequencies are read on one direct-reading illuminated dial with an accuracy of ± 1 percent. The pulse is analyzed on a five-inch cathode ray tube. Conventional oscilloscope controls are included to adjust the image for proper analysis. The spectrum width of the pulse can be made to represent a frequency width of from 1/2 to 25 megacycles. A variable amplitude spectrum calibrator (frequency-marker oscillator) with a flat output and a frequency range of + and - 15 megacycles is provided. The entire instrument is contained in two sliding-drawer units. The two units comprising the analyzer instrument are the Pulse Analyzer Indicator and the R-F Tuner. A transit case is supplied for storage and shipment of the instrument. Cable assemblies and two variable r-f attenuators are also supplied and are located on the interior of the transit case.

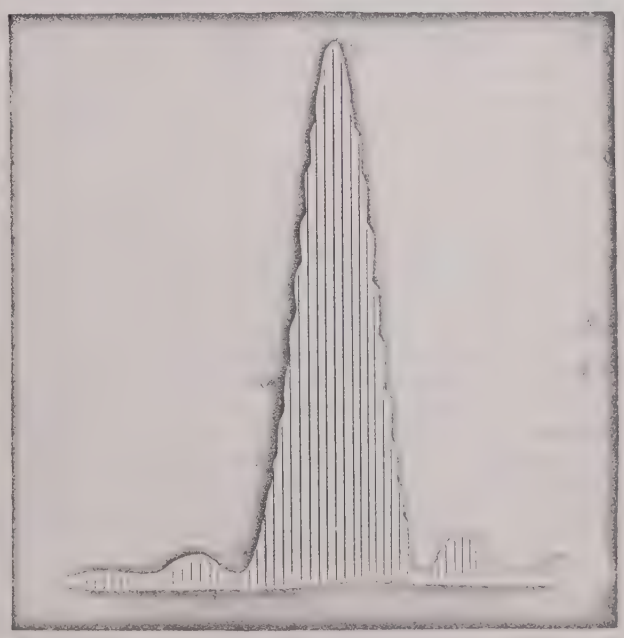


Figure 1-2. Typical Rectangular R-F Pulse Analyzed on Spectrum Analyzer LA-17

1-9. PULSE ANALYZER INDICATOR.

NOTE

All panel controls referred to in this handbook are spelled exactly as marked on the equipment.

1-10. Figure 1-1 reveals the location of the pulse analyzer indicator unit which constitutes the upper half on the analyzer instrument. The indicator unit panel primarily consists of a five-inch cathode ray tube, type 5CP1A, and associated controls to aid in adjusting the various wave shapes viewed for proper analysis. The controls used to accomplish this purpose are "HORIZ CENTERING", "VERT CENTERING", HORIZ GAIN", "VERT GAIN", "SWEEP FREQ", "SPECTRUM WIDTH", "SPECTRUM CALIBRATOR", "FOCUS", "BRIGHTNESS", "SPECTRUM CENTERING", "SYNC" and "INTENSIFIER". A voltmeter is included on the panel for indicating either the line voltage (115 volts input), i-f amplifier plate voltage or negative supply potential. The voltages to be read are selectable by use of the "METER SELECTOR" knob. An on-off switch is located on the panel for starting the equipment in operation. Two "3 AMP" input-power fuses are mounted on the panel and can be easily removed and replaced, if defective. Two spare fuses are provided for maintenance purposes. The two covered screwdriver-adjustment potentiometers "SYNC" and "INTENSIFIER" are included for conveniently synchronizing the sweep frequency, and to vary the average intensity of the vertical deflection signals on the scope, respectively.

1-11. The interior of the indicator unit primarily consists of a sweep frequency generator strip, spectrum calibrator, two i-f amplifier strips (1 mc and 64 mc), low-voltage power supply-sweep and video, and a high-voltage power supply. Two interior indicator lamps, placed on both sides of the scope screen, provide illumination for the markings on the reticule (the plexiglass assembly mounted in front of the KRT tube face). The intensity of the two indicator lamps is varied by rotating the "SCALE ILLUMINATION" control on the front panel of the indicator unit.

1-12. R-F TUNER.

1-13. Figure 1-1 reveals the location of the r-f tuner unit which constitutes the lower half of the analyzer instrument. The r-f tuner unit panel consists of a direct-reading illuminated dial, "FREQUENCY IN MEGACYCLES", which displays the frequency of the local oscillator located in the tuner unit. The frequency of the local oscillators is adjusted by the "TUNE" control, and as the "TUNE" knob is varied the dial rotates to indicate the frequency to which the input is tuned. The band of frequencies to be read on the dial is selected by use of a seven-position "BAND SELECTOR" switch which enables the entire range of frequencies from 10 to 16,000 megacycles to be tuned. Four input receptacles "JNPUT MCS" are included on the panel for connecting the analyzer to the radar or other equipment to be tested. To check the specified range of frequencies desired (10-150, 150-350, 350-1000, 1000-16000 megacycles), the appropriate input receptacle must be used. In conjunction with this, the "BAND SELECTOR" knob must be placed on the corresponding frequency range labeled on the panel.

1-14. The interior of the r-f tuner unit primarily consists of three oscillators, oscillators 1 and 2, and oscillator 3 and oscillator 4, along with the i-f amplifier strip (160 mc). Also included is a gear train assembly which is connected to the "TUNE" control, the "FREQUENCY IN MEGACYCLES" dial, and to the three oscillator assemblies. Thus, during tuning operation, as the "TUNE" control is manipulated, the frequency dial rotates simultaneously with the variable elements in the local oscillators.

1-15. VARIABLE R-F ATTENUATORS. Two variable r-f attenuators are supplied and used: the Variable R-F Attenuator and the Variable R-F Attenuator (see figure 1-3). The former covers a frequency range of 1 to 4 kilomegacycles while the latter covers a range from 4 to 12.4 kilomegacycles. Both attenuators are of the waveguide-below-cutoff type and operate in the TE1.1 mode (inductive coupling). The R-F Attenuator contains a 50-ohm termination. The output impedance of the attenuator is varied by rotating the calibrated micrometer adjustment. Each revolution of the micrometer barrel changes the attenuation 20 db, the range of readings being from -9 db to 140 db. The R-F Attenuator micrometer adjustment contains two major divisions marked 50 and 100, and 25 sub-divisions, each corresponding to a change of five points on the scale. Each revolution of the micrometer barrel changes the scale setting by one sub-division, corresponding to an attenuation of approximately 11 db (at 9430 mcs).

1-16. SUPPLEMENTARY DATA.

1-17. Data included in this handbook covers only one model of the equipment. Supplementary data on the Spectrum Analyzer is given in Tables I, II and III. Table I, Equipment Limitations, lists the operating characteristics of the test instrument. Table II, Equipment Supplied, lists the components supplied to the operating activity as part of the analyzer equipment, Table III, Equipment Required but not Supplied, lists the components not supplied but are required by the operating activity to operate the analyzer. Each item tabulated indicates the quantity required for a typical installation, the short form name, and Government type designation.

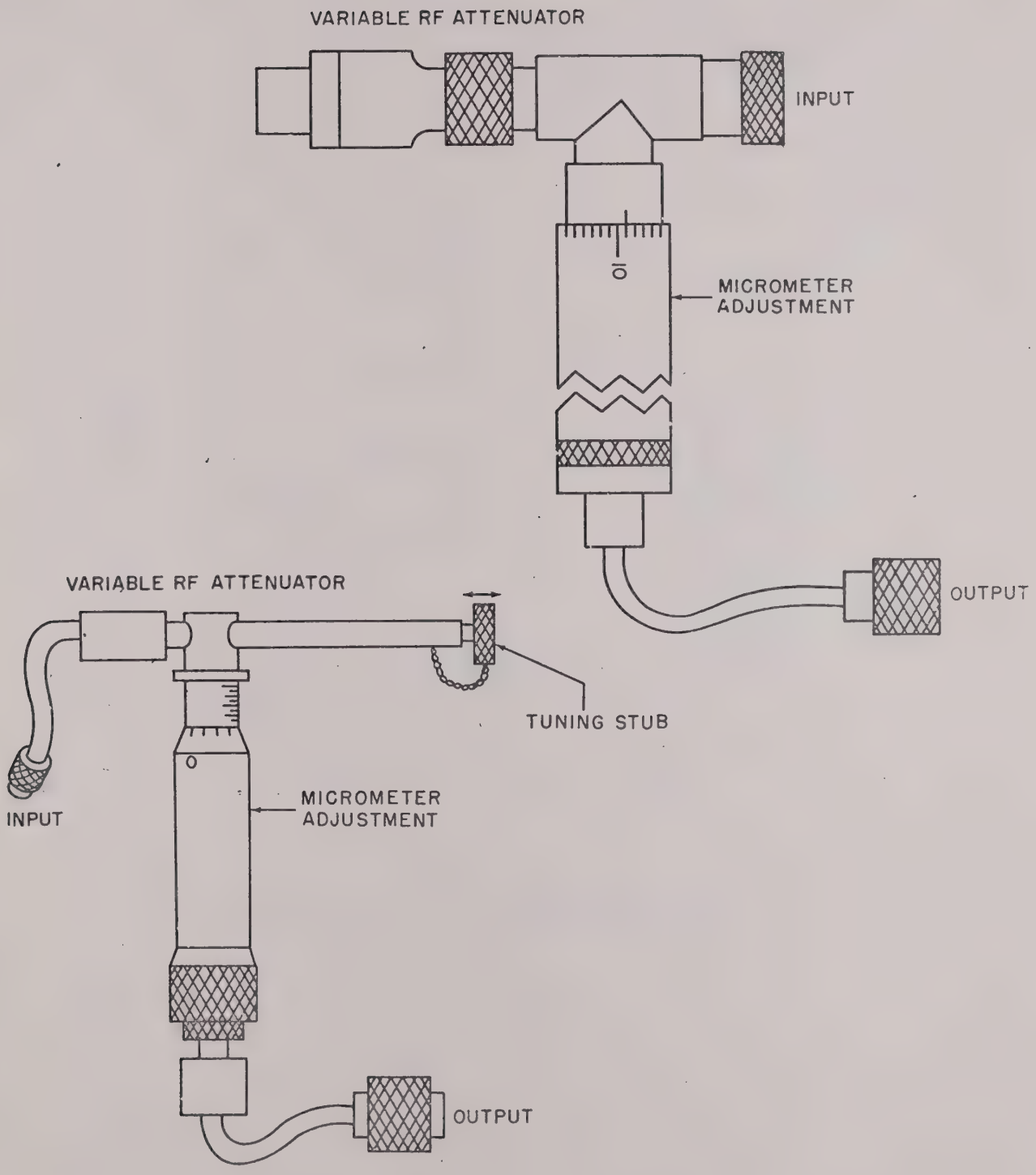


Figure 1-3. Variable R-F Attenuator

TABLE I. EQUIPMENT LIMITATIONS

POWER REQUIREMENTS	FREQUENCY RANGE	(1 inch deflection, 1 mc spectrum width) RANGE (mc)	SENSITIVITY (dbm)	STABILITY	SPECTRUM WIDTH	RESOLUTION	TEMPERATURE RANGE
115 volts, 50-1000 cps, 250 watts, max.	10 to 16,000 megacycles	10-150	-63	± 0.5% under all operating conditions	0.5 to 25 mc	10 kc	OPERATING: 0° C to + 55° C (32°F to 131°F) NON-OPERATING: -41° C to +71° C (-40° F to 160°F)
		150-350	-57				
		350-1000	-52				
		1000-16,000	-50				
		1000-16,000	-40 (25 mc spectrum width)				

TABLE II. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	GOVERNMENT TYPE DESIGNATION
1	Pulse Analyzer Indicator	IP-130/UPM-17
1	R-F Tuner	TN-138/UPM
1	Variable R-F Attenuator	CN-319/UPM-17
1	Variable R-F Attenuator	CN-211/U
1	Case	CY-903/UPM-17
1	Cord - 10 feet	CX-1059/U
1	Cord - 6 feet	CG-92E/U
1	Cord - 6 feet	CG-409E/U
1	Special Purpose Cable Assembly	CX-3162/U
1	Special Purpose Cable Assembly	CX-3163/U

TABLE III. EQUIPMENT REQUIRED BUT NOT SUPPLIED

No equipment is required other than that supplied.

INFORMATION NOTE

The local oscillator operates above signal frequency from 10 to 1000 mc, and below signal frequency from 1000 to 16,000 mc.

SECTION II

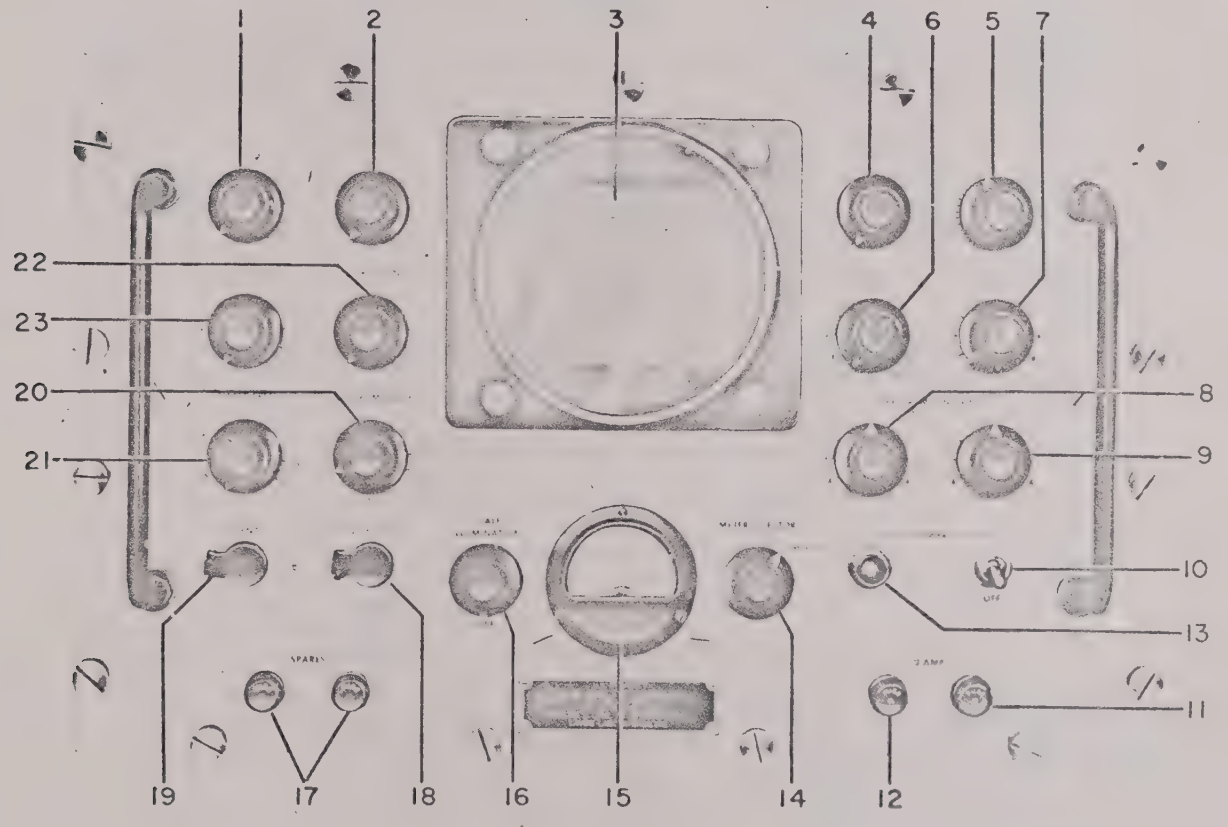
OPERATING PROCEDURES

2-1. GENERAL.

2-2. This section contains information on the operating procedures to be followed when using the Spectrum Analyzer LA-17 as a test instrument. The instrument can be used to check frequency modulation and frequency stability of an r-f oscillator as well as to measure the pulse width and bandwidth of the r-f oscillator pulse. A description is given of all controls to be used in operating the instrument along with the sequence of operation to be followed for performing each test. Typical instrument readings and scope presentations obtained during each test are included, together with any distinguishing features which may assist the operator in identifying the wave shapes presented.

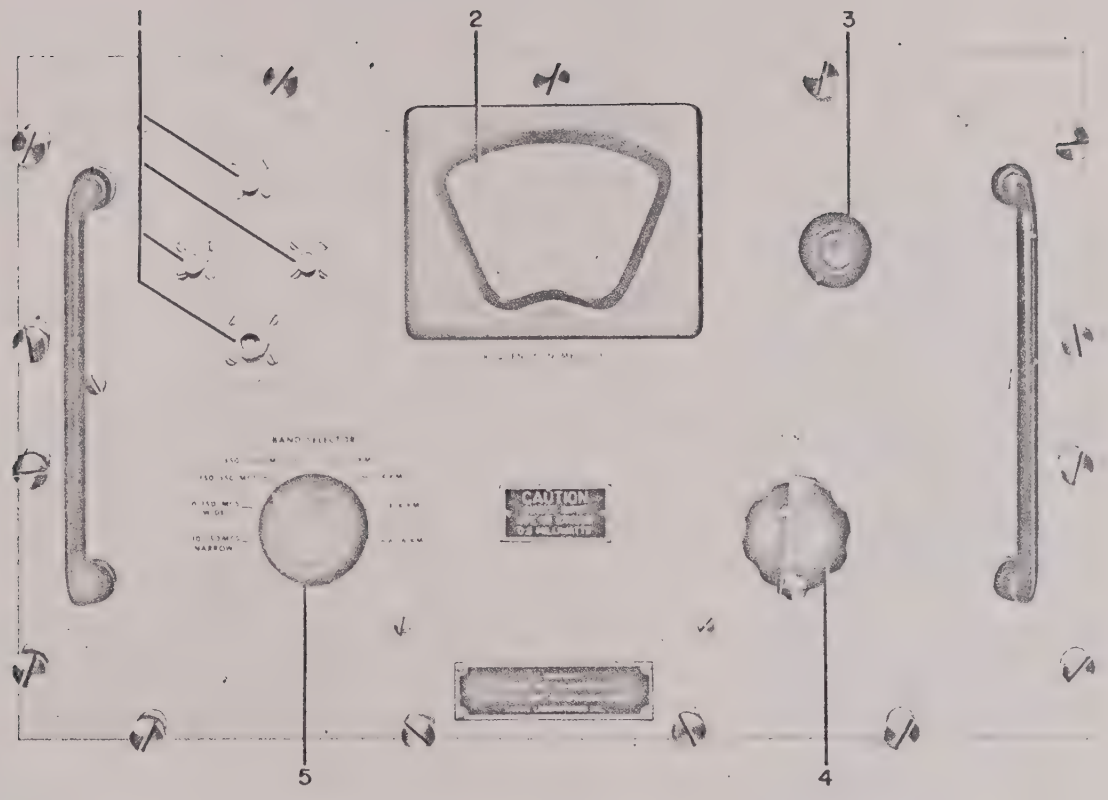
2-3. DESCRIPTION OF CONTROLS.

2-4. Shown in table IV is a list and description of panel controls to be used by the operator when employing the analyzer for testing purposes. All controls are referred to exactly as marked on the equipment. The controls described in table IV are shown in figures 2-1 and 2-2.



1. "HORIZ CENTERING" knob
2. "VERT CENTERING" knob
3. Cathode Ray Tube Screen
4. "SPECTRUM CALIBRATOR" - "AMPLITUDE" knob
5. "SPECTRUM CALIBRATOR" - "FREQUENCY" knob
6. "FOCUS" knob
7. "BRIGHTNESS" knob
8. "SPECTRUM CENTERING" - "COARSE" knob
9. "SPECTRUM CENTERING" - "FINE" knob
10. "POWER" switch
11. "3 AMP" fuse
12. "3 AMP" fuse
13. "POWER" indicator lamp
14. "METER SELECTOR" switch
15. Voltmeter indicator
16. "SCALE ILLUMINATION" knob
17. "SPARES" (fuses)
18. "INTENSIFIER" screwdriver-adjustment control
19. "SYNC" screwdriver-adjustment control
20. "SPECTRUM WIDTH" knob
21. "SWEEP FREQ" knob
22. "VERT GAIN" knob
23. "HORIZ GAIN" knob

Figure 2-1. Pulse Analyzer Indicator, Front Panel View



1. "INPUT-MCS" cable receptacles
2. "FREQUENCY IN MEGACYCLES" dial
3. "I-F ATTENUATION DB" knob
4. "TUNE" knob
5. "BAND SELECTOR" knob

Figure 2-2. R-F Tuner, Front Panel View

TABLE IV. OPERATING CONTROLS

Pulse Analyzer Indicator

Control	Figure and Index No.	Type and Designation	Function
"POWER"	13, figure 2-1	Indicator, T1003	When lit, indicates that input power is being delivered to the analyzer from an external source of a-c supply.
	10, figure 2-1	Switch, S1003	When not in the "OFF" position places the analyzer in operation by feeding the 115-volt, 60-cps input to the power supply circuitry. In this position Indicator I1003 is lit.
"METER SELECTOR"	14, figure 2-1	Switch, S1002	In the "+150 V" position, enables positive supply potential to be read on the voltmeter indicator. In the "-150 V" position, enables negative supply potential to be read. In the "LINE VOLTS" position, enables input voltage (line voltage) to the analyzer to be read.

TABLE IV. OPERATING CONTROLS (cont)

Control	Figure and Index No.	Type and Designation	Function
"SCALE ILLUMINATION"	16, figure 2-1	Switch, S1001 Potentiometer, R1003	An on-off switch arrangement with variable resistance control for turning on the scope indicator lamps behind the panel which are used for illuminating the reticule and the scope screen. The control is used to vary the intensity of the scope indicator lamps.
"INTENSIFIER"	18, figure 2-1	Potentiometer, R1341	Varies the intensity of only the vertical deflection signals seen on the scope screen.
"SYNC"	19, figure 2-1	Potentiometer, R1301	Synchronizes the sweep frequency to a submultiple of the line frequency. Synchronization increases in CW direction.
"HORIZ CENTERING"	1, figure 2-1	Potentiometer, R1323	Directs the wave shape in the horizontal direction or X axis on the scope screen. Used to horizontally center the image viewed on the scope.
"VERT CENTERING"	2, figure 2-1	Potentiometer, R1336	Directs the wave shape in the vertical direction or Y axis on the scope screen. Used to vertically position the image viewed on the scope.
"HORIZ GAIN"	23, figure 2-1	Potentiometer, R1317	Narrows or broadens the baseline and image or wave shape viewed on the scope screen to the width of the reticule.
"VERT GAIN"	22, figure 2-1	Potentiomer, R1325	Increases or decreases the amplitude of the image viewed on the scope screen. (Do not operate below 1-1/2 divisions to avoid saturation of square law detector.
"SWEEP FREQ"	21, figure 2-1	Potentiometer, R1307B	Controls the frequency on the sweep as displayed on the scope.
"SPECTRUM WIDTH"	20, figure 2-1	Potentiometer, R1314	Calibrates the entire width of the reticule (10 cm. wide) on the scope screen to represent a bandwidth of 1/2 to 25 megacycles. When analyzing frequencies below 50 mc, and the "BAND SELECTOR" switch is on "NARROW", this control should be limited to value below the frequency being analyzed.
"SPECTRUM CALIBRATOR"			Presents a pip which acts as a marker on the scope screen. The pip is adjustable in amplitude and frequency. The pip allows frequency measurements within the bandwidth of the 160 mc IF to be made with ease.

TABLE IV. OPERATING CONTROLS (cont)

Pulse Analyzer Indicator

Control	Figure and Index No.	Type and Designation	Function
"AMPLITUDE"	4, figure 2-1	Potentiometer, R1014	"AMPLITUDE" control varies the amplitude of the marker pip and shuts it off.
"FREQUENCY"	5, figure 2-1	Variable Capacitor, C1403	"FREQUENCY" control varies the frequency (and therefore, position) of the pip.
"FOCUS"	6, figure 2-1	Potentiometer, R1006	Controls the sharpness or distinction of the image displayed on the scope screen for viewing purposes.
"BRIGHTNESS"	7, figure 2-1	Potentiometer, R1004	Used to vary the brightness of the pulse or any deflection pattern seen on the scope.
"SPECTRUM CENTERING"			Changes the frequency spectrum electronically to center of reticule.
"COARSE"	8, figure 2-1	Potentiometer, R1017	"COARSE" control varies the spectrum frequency in a coarse manner.
"FINE"	9, figure 2-1	Potentiometer, R1018	"FINE" control varies the spectrum frequency in a fine manner.
"3 AMP"	11, 12, figure 2-1	Fuses F1001, F1002	Protects the analyzer instrument against overload.
"SPARES"	17, figure 2-1	Spare Fuses, F1001, F1002	Spare fuses to be used in the event the "3 AMP" fuses become defective.
		R-F TUNER	
"FREQUENCY IN NEGA-CYCLES	2, figure 2-2	Dial mechanically connected to the shaft of the "TUNE" control	Indicates frequency of signal to which analyzer is tuned. Dial rotates as "TUNE" control is varied clockwise or counterclockwise.
"TUNE"	4, figure 2-2	Knob connected by gearing to variable capacitors C2503 and C2517 in oscillators 1 and 2 and moving pistons in oscillator 3 and oscillator 4.	Used to adjust the frequency of the signal to which analyzer is tuned. By rotating the "TUNE" control capacitors C2503 and C2517 and the moving pistons vary to change the oscillator frequency.
"BAND SELECTOR"	5, figure 2-2	Selector Switch, S2001	Used to select the frequency band desired for analyzing.
"INPUT-MCS"	1, figure 2-2	Receptacles:	Signal input receptacles used for connecting the analyzer instrument to the equipment to be tested.
"10-150"		J2004	Input receptacle used for analyzing frequencies between 10 and 150 mc.
"150-350"		J2005	Input receptacle used for analyzing frequencies between 150 and 350 mc.
"350-1000"		J2006	Input receptacle used for analyzing frequencies between 350 and 1000 mc.
"1000-16,000"		J2007	Input receptacle used for checking frequencies between 1000 and 16,000 mc.
"I-F ATTENUATION DB"	3, figure 2-2	Selector Switch, S2002	Controls attenuation of output of 160 mc i-f amplifier.

2-5. SEQUENCE OF OPERATION.

2-6. Plug the analyzer power cord into an external supply of 115 volts, 50 to 1000 cps, ac.

2-7. Throw on the "POWER" switch (10, figure 2-1) to start operation of the equipment. Observe the "POWER" indicator lamp (13). It must light.

2-8. Rotate the "METER SELECTOR" knob (14, figure 2-1) to "LINE VOLTS". Observe the indicated voltage reading on the voltmeter (15). It should read approximately 115 volts.

2-9. Observe the scope screen for a few seconds until a line trace appears. If no trace appears rotate "BRIGHTNESS" control (9, figure 2-1) clockwise. Normal position of this control is about "5". An example of the scope trace to be expected is shown in figure 2-3.

2-10. Adjust "HORIZ CENTERING" knob (1, figure 2-1) and the "VERT CENTERING" knob (2) to place the trace on the base line or X axis of the recticule. Normal position of both these controls is at "5". The appearance of the trace should be as indicated on figure 2-4.

2-11. Adjust "HORIZ GAIN" (23, figure 2-1) to make display 10 centimeters wide on reticule Adjust the "SWEEP FREQ" control (21) to the desired frequency. With these adjustments made, the trace must appear as shown in figure 2-5.

2-12. Open the "SYNC" (19, figure 2-1) cap and adjust, by means of a screwdriver, the "SYNC" potentiometer to synchronize the display on the scope screen. Adjust "FOCUS" control (6) for sharpness of trace. See figure 2-6 for proper synchronization of trace.

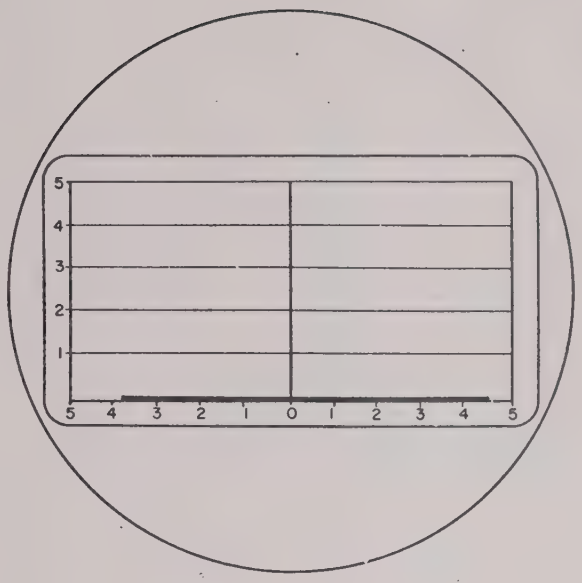


Figure 2-4. Line Trace on Scope With Proper Centering

NOTE

Make certain that the sweep rate is not set off by a sub-multiple of the line frequency. It may be necessary to adjust the "SYNC" control to lock the sweep rate.

2-13. Connect the r-f cables to the appropriately marked receptacles "INPUT-MCS" (1, figure 2-2) on the r-f tuner unit panel, and to the equipment to be tested.

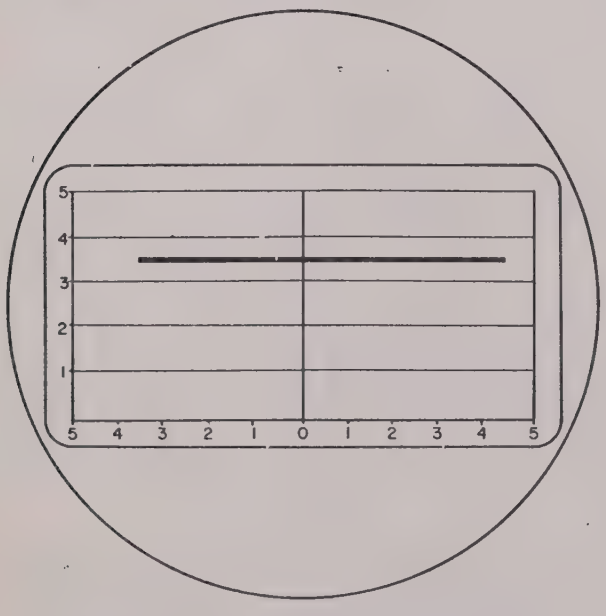


Figure 2-3. Line Trace on Scope With Proper Brightness

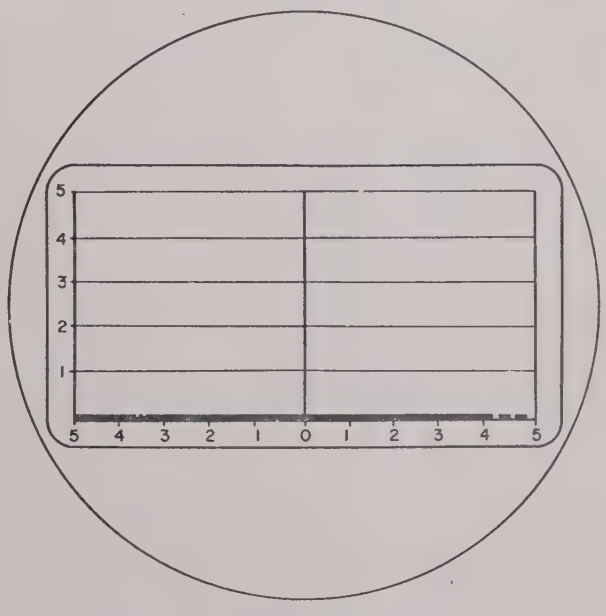


Figure 2-5. Line Trace on Scope With Proper Horizontal Gain

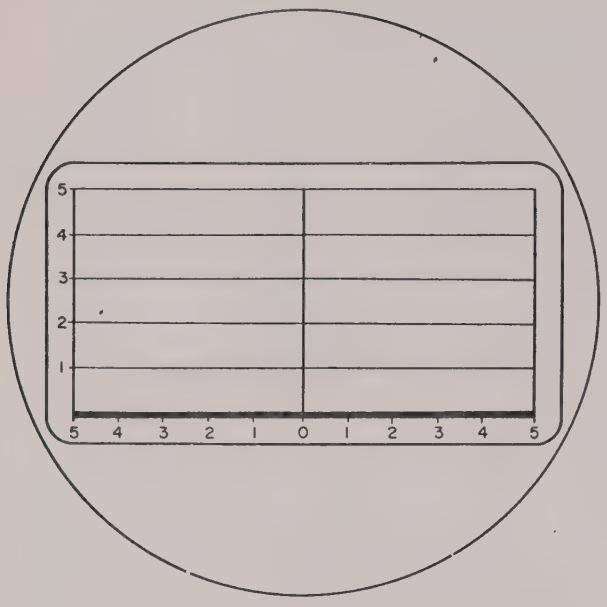


Figure 2-6 Line Trace on Scope With Proper Synchronization

CAUTION

The two attenuators must be used whenever it is determined that the input signal is in excess of 1/2 milliwatt. If the input signal lever cannot readily be determined, exercise care by connecting the attenuators prior to performing signal analysis checks on the analyzer instrument. If it is then determined during instrument operation that insufficient signal is being received, the attenuators may be removed. See paragraph 2-18 for procedures concerning use of the attenuators.

2-14. Rotate the "BAND SELECTOR" knob (5, figure 2-2) to the desired frequency range.

2-15. Rotate the "TUNE" knob (4, figure 2-2) to the desired frequency (until signal appears on the scope). For an example of a rectangular pulse viewed on scope screen see figure 2-7.

2-16. Rotate the "I-F ATTENUATION DB" knob (3, figure 2-2) to the desired pulse amplitude on the scope. Set the "VERT GAIN" (22, figure 2-1) to the desired height and note the "VERT GAIN" setting. Keep this control above 1-1/2 divisions. See figure 2-8 for appearance of r-f pulse after attenuation and vertical gain adjustments have been made.

NOTE

Use the "SPECTRUM WIDTH" control during frequency analysis whenever it is desired to calibrate the width of the scope reticule to represent a bandwidth from 1/2 to 25 mc. Refer to Table IV for the function of this control.

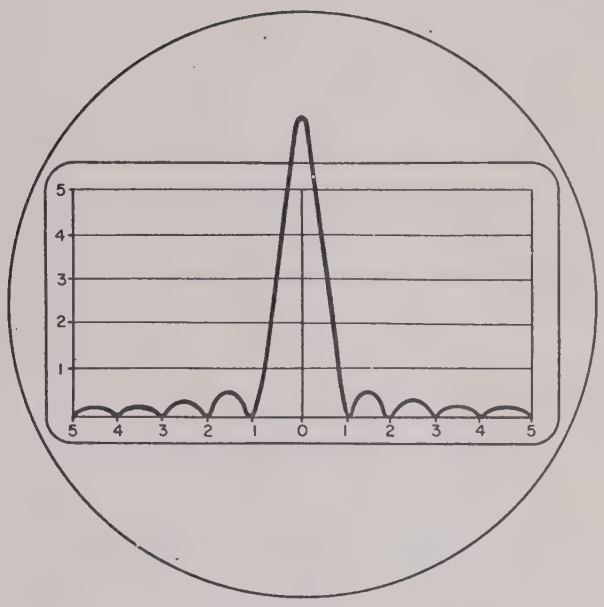


Figure 2-7 Typical R-F Pulse on Scope before Vertical Gain and I-F Attenuation Adjustments

2-17. Turn the "VERT GAIN" (22, figure 2-1) down to "O". Adjust the "BRIGHTNESS" (7) control until the base line just disappears. Return the "VERT GAIN" to the position set in paragraph 2-16. Open the "INTENSIFIER" cap (18, figure 2-1) and rotate, by means of a screwdriver, the "INTENSIFIER" potentiometer clockwise until the vertical signals are visible to a desired intensity. See figure 2-9 for a typical view obtained under such conditions. The image will

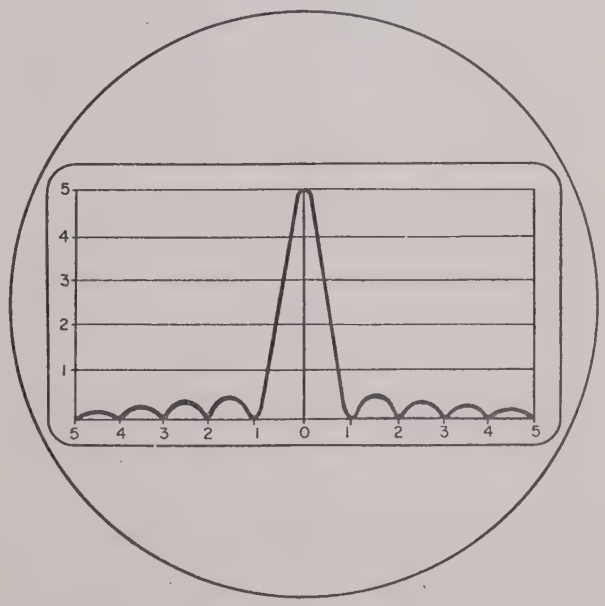


Figure 2-8. Typical R-F Pulse on Scope after Vertical Gain and I-F Attenuation Adjustments

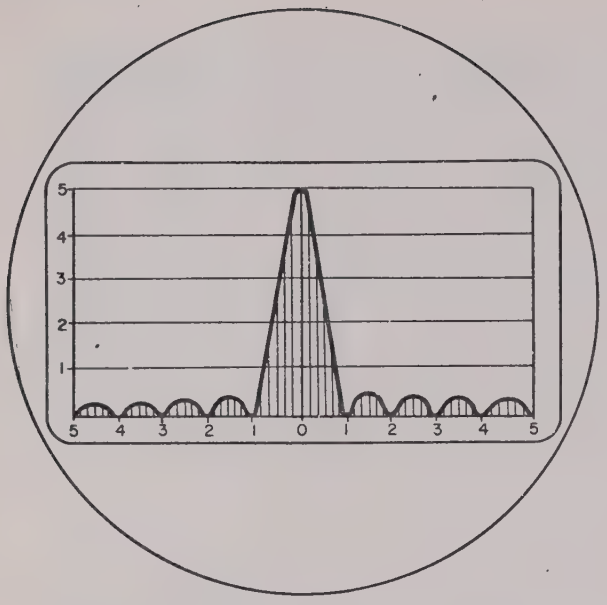


Figure 2-9. R-F Pulse Properly Adjusted

consist solely of vertical lines of various heights. The intensity of the curve bounding the vertical lines is exaggerated.

2-18. USE OF R-F ATTENUATOR. Graphs are provided to illustrate the characteristics of the r-f attenuator which is used in the frequency ranges of 4 to 12.4 kmcs. Figure 2-10 reveals the insertion loss at zero db setting of this attenuator. The calibration curve of the attenuator appears in figure 2-11 and indicates the attenuation of various readings obtained on the micrometer. This curve shows the effect of $TM_{0,1}$ mode of operation (capacitive coupling) as effective primarily at low attenuation causing a departure from linearity of attenuation. The curve only applies to sources of approximately 50 ohms impedance. The calibration chart must be corrected if sources of other impedance values are used. The tuning stub provided enables the impedance to be tuned so as to maximize the output, allowing the calibration curve to apply more closely. At higher frequencies the attenuation is reduced due to the wave-

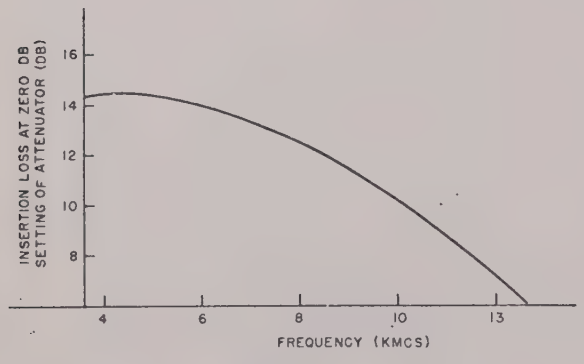


Figure 2-10. Insertion Loss at Zero Setting of R-F Attenuator

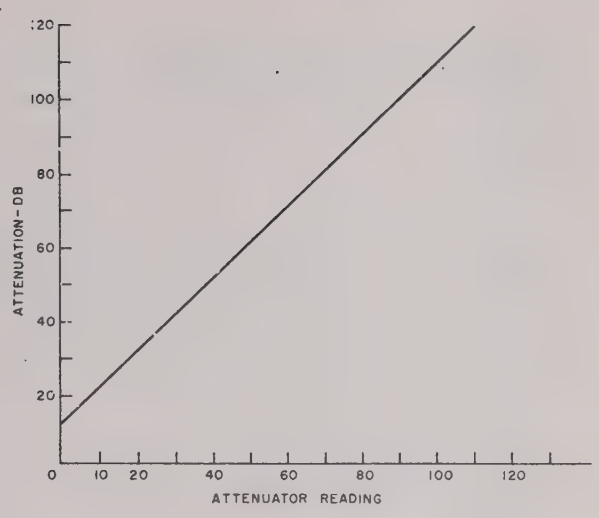


Figure 2-11. Attenuator Calibration Curve at 9430 mcs for the R-F Attenuator

guide approaching its cutoff frequency. To correct for this effect, it is necessary to multiply the indicated attenuation found in figure 2-11 by the correction factor shown by the curve of figure 2-12, Frequency Correction Factors. The actual attenuation is then the correction factor (K) times the indicated attenuation.

2-19. USE OF R-F ATTENUATOR. Graphs are provided to illustrate the characteristics of the r-f attenuator which is used in the frequency ranges of one to four kilomegacycles. Figure 2-13 is the correction chart used in correcting the error resulting from the coupling of the $TM_{0,1}$ mode when the exciting line is terminated in its characteristic impedance. Note that for each attenuator reading (A) a certain correction factor (C) exists. To obtain the appropriate attenuation use the formula shown in the figure. The accuracy of the indicated relative attenuation, when this chart is used, is $\pm$ (1.5 percent $\pm$ .2 db) at frequencies to 2000 mcs. At the higher

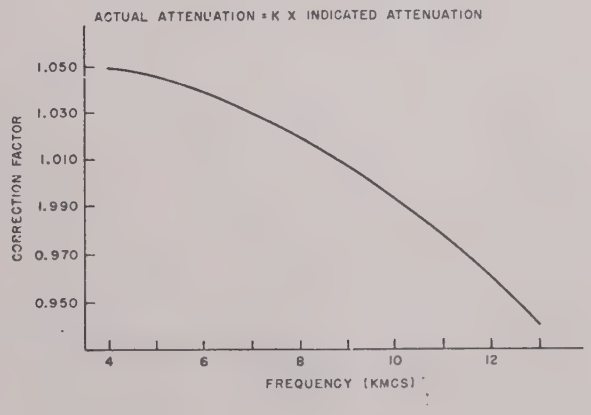


Figure 2-12. Frequency Correction Factor for the R-F Attenuator

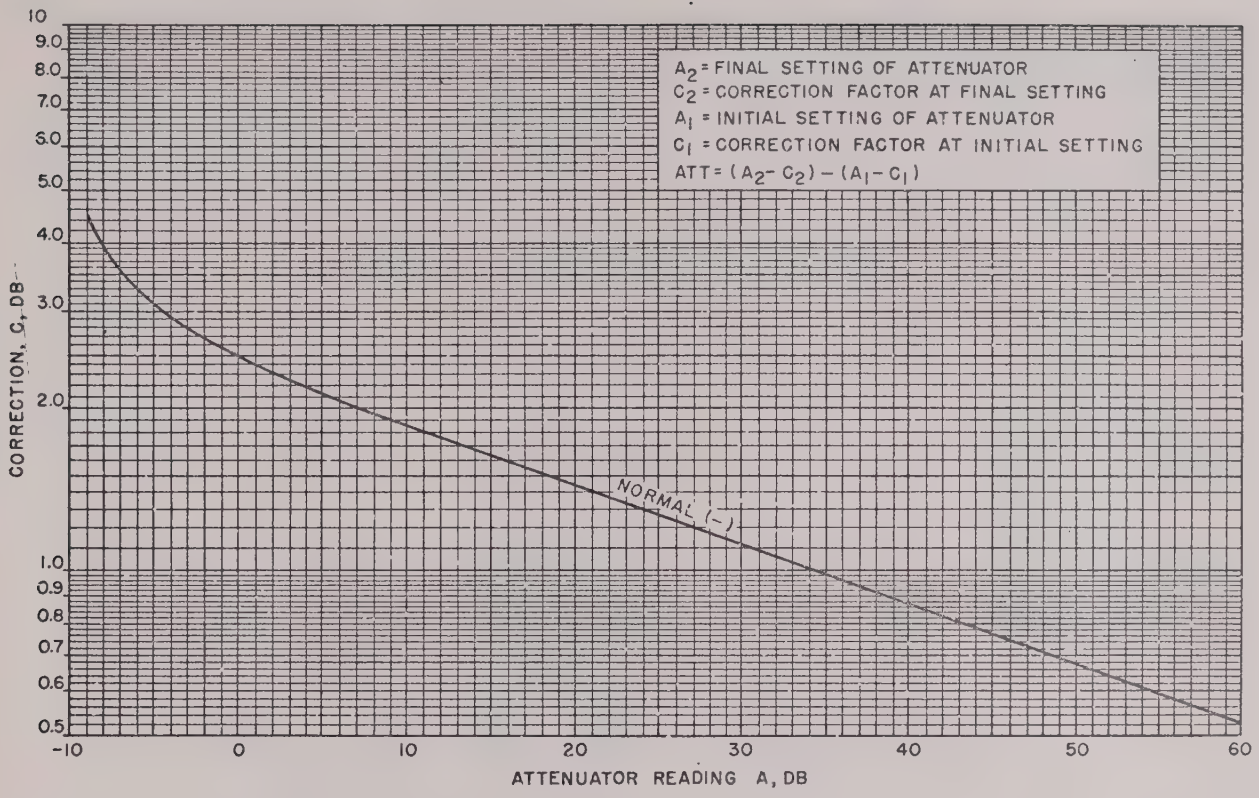


Figure 2-13. Correction Chart for R-F Attenuator

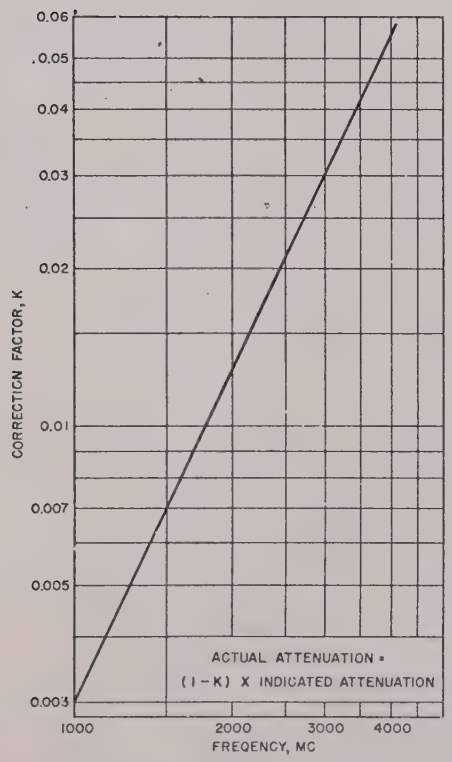


Figure 2-14. Frequency Correction Factor For R-F Attenuator

frequencies the attenuation is reduced due to the waveguide approaching its cutoff frequency. To correct for this effect, multiply the indicated attenuation by the factor found in figure 2-14 corresponding to the operating frequency. The actual attenuation is then equal to that specified in figure 2-14. Shown in figure 2-15 is the relationship of the SWR in db with frequency.

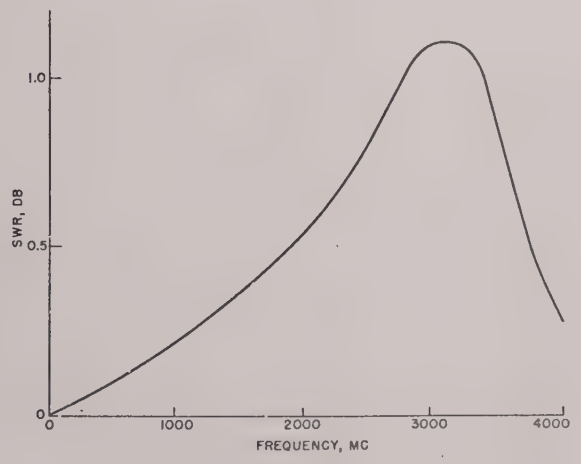


Figure 2-15. SWR Introduced in a Flat Line by the Insertion of the R-F Attenuator

2-20. TESTS PERFORMED WITH THE SPECTRUM ANALYZER.

2-21. The basic tests made on radar transmitters or other equipment with the spectrum analyzer are conveniently tabulated in table V. The table indicates the type of test which can be made, along with special instructions on the procedure to follow when performing each test. A typical scope pattern encountered for each test is illustrated and remarks are given on the analysis and interpretation of the pattern observed. The analyzer can be used to check the spectrum of a magnetron or a pulsed test oscillator, the frequency stability of klystrons and magnetrons, the bandwidth and pulse width of r-f oscillators, the modulated output of magnetrons to find that no excessive frequency modulation exists, and for other purposes.

TABLE V. EXAMPLES OF ANALYZER USES

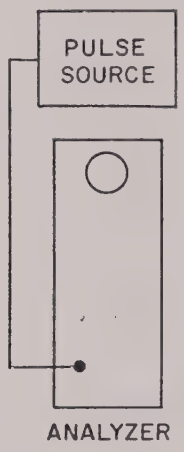
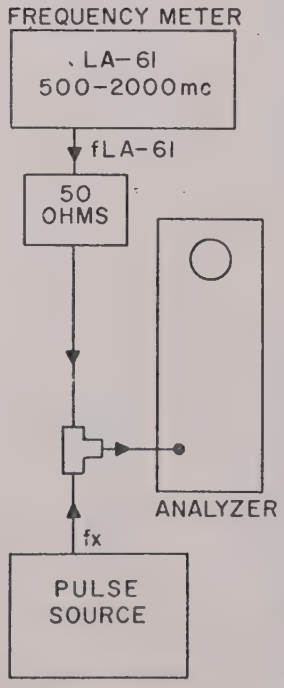
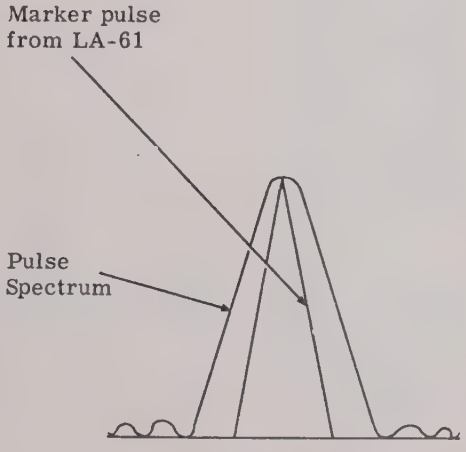
TYPE OF TEST	SET UP	PROCEDURE	SCOPE PATTERN	INTERPRETATION
Checking frequency stability of klystrons and magnetrons		Follow steps 2-6 through 2-17. Set "SPECTRUM CALIBRATOR" by adjusting the "AMPLITUDE" and "FREQUENCY" control until a single frequency cw signal appears on the scope. Allow signal to stand for a few minutes to check for drift.	 Single frequency cw pip or marker signal	Single frequency cw pip or marker present. If the signal on the screen does not drift, with respect to Spectrum Calibrator marker, frequency stability is proper. Any occurring drift is a sign of nonstable operation.
Method for measuring frequencies higher than 500 mc within 0.001% using the LA-61 frequency meter.		1. Obtain f_x on screen. 2. Determine exact f_{LO} of the spectrum and analyzer via the frequency meter LA-61. 3. Set the LA-61 frequency meter 160 mc higher than the f_{LO} determined in step 2. 4. Zero beat the marker signal with frequency (f_x) signal. 5. Read the exact frequency on the LA-61 frequency meter. This frequency is f LA-61. 6. Obtain the difference frequency fd as follows: $fd = f\,LA\text{-}61 - f_{LO}$		

TABLE V. EXAMPLES OF ANALYZER USES (cont)

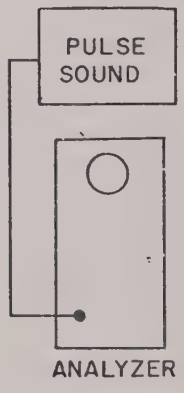
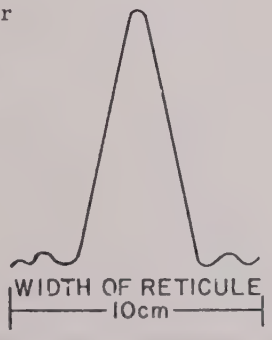
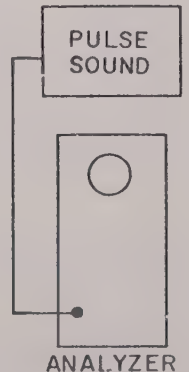
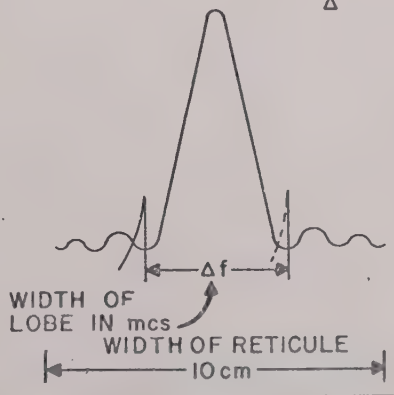
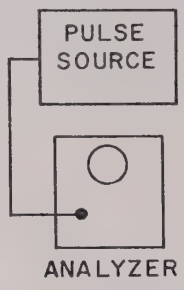
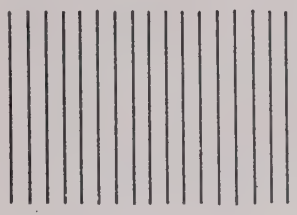
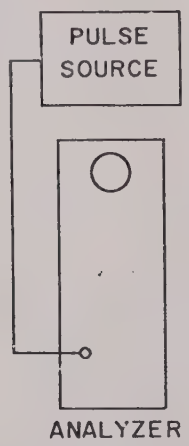
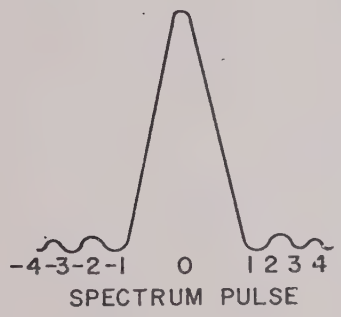
TYPE OF TEST	SET UP	PROCEDURE	SCOPE PATTERN	INTERPRETATION
		7. Obtain the unknown frequency f_x as follows: $f_x = H(f_{LO}) + f_d$ SYMBOL DESIGNATION: f_x = Unknown frequency to be measured. f_{LO} = local oscillator frequency of spectrum analyzer. f_d = difference frequency. f_{LA-61} = frequency of LA-61 where marker signal is zero beating with f_x on LA-61. H = harmonic of the spectrum anlyzer local oscillator		
Checking bandwidth of r-f oscillators.		Follow steps 2-6 through 2-17. Use "SPECTRUM WIDTH" control for calibrating the 10-cm reticule width to represent a bandwidth suitable for measuring the width of the pulse.		10 cm corresponds to the quantitative figure in "MCS" to which the "SPECTRUM WIDTH" control is positioned. The centimeter width of the pulse represents a corresponding value in megacycles. Ex: If 10 cm = 20 mc, 5 cm = 10 mc 1 cm = 2 mc
Checking pulse width of r-f oscillator.		Follow steps 2-6 through 2-17. Use single frequency cw pip or marker to measure the width of the main lobe with aid of reticule division. Use "SPECTRUM WIDTH" control for calibrating the 10-cm reticule width to represent a bandwidth suitable for measuring the width of the main lobe of the pulse. Adjustment of "SPECTRUM CALIBRATOR" produces marker on scope screen.		Pulse width is equal to $\frac{2}{\Delta}$.

TABLE V. EXAMPLES OF ANALYZER USES (cont)

TYPE OF TEST	SET UP	PROCEDURE	SCOPE PATTERN	INTERPRETATION
Checking modulated output of magnetrons		Follow steps 2-6 through 2-17.		Flat frequency modulation. Pattern signifies modulated output of magnetron is proper. If current pulse is not flat excessive frequency modulation exists.
Checking the spectrum of a magnetron or a pulsed test oscillator		Follow steps 2-6 through 2-17.		Spectrum of a rectangular pulse with neither amplitude nor frequency modulation during the pulse. The pulse is symmetrical. Minima in the spectrum cover at ±1 mc/Sec, ±2 mc/Sec, etc. Therefore, the pulse shown is representative of a properly operating magnetron or a good pulsed test oscillator.

2-22. ANALYSIS OF VARIOUS SCOPE PRESENTATIONS.

2-23. Various scope patterns may be encountered while checking the spectra of radar transmitters. The spectrum patterns most commonly encountered may signify proper or improper operation. Examples of proper and improper spectra are illustrated in figures 2-16 through figures 2-23 and an analysis of each pattern is given in the following paragraphs.

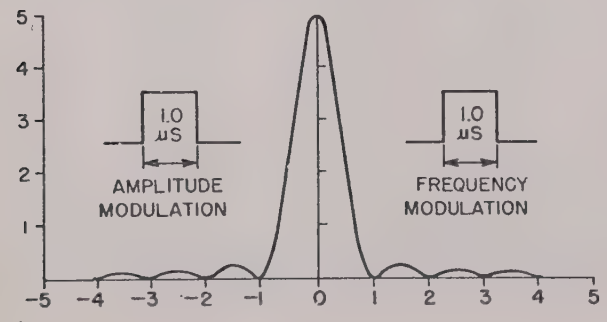


Figure 2-16. Rectangular Pulse with Neither Amplitude nor Frequency Modulation during the Pulse

2-24. Shown in figure 2-16 is a spectrum of a rectangular pulse with neither amplitude nor frequency modulation during the pulse. The form of the spectrum is obviously symmetrical. Minima in the spectrum occur at ± 1 mc/sec, ±2 mc/sec, ±3 mc / sec, and so forth. This is representative of the spectrum of a properly operating magnetron or of a good pulsed oscillator.

2-25. Figure 2-17 illustrates the spectrum of a symmetrical trapezoidal voltage pulse with no frequency modulation. The pulse is one microsecond wide at the base and 0.6 microseconds wide at the top. The pulse is shorter than a one microsecond rectangular pulse and, accordingly, the first minima occur at frequencies which differ by slightly more than two mc/sec. The most notable difference between the shape of this spectrum and that revealed in figure 2-16 is the reduction of amplitude of the side lobes relative to the center lobe.

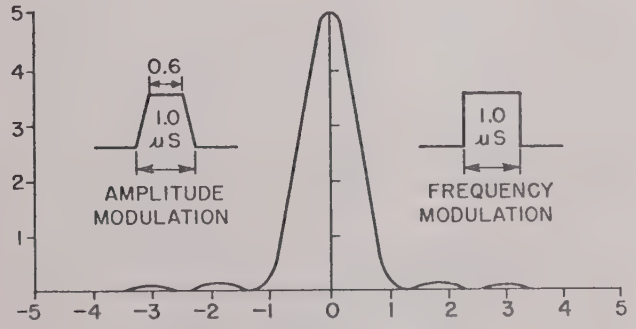


Figure 2-17. Symmetrical Trapezoidal Voltage Pulse with no Frequency Modulation

2-26. Revealed in figure 2-18 is the spectrum of a symmetrical triangular voltage pulse with no frequency modulation. Since the pulse is one microsecond wide at the base and traingular, the pulse is shorter than a one-microsecond rectangular pulse. Accordingly, the first minima are at frequencies differing by more than two mc/sec. The minima occur at ± 2 mc/sec, ± 4 mc/sec, and so forth. The side lobes are practically negligible.

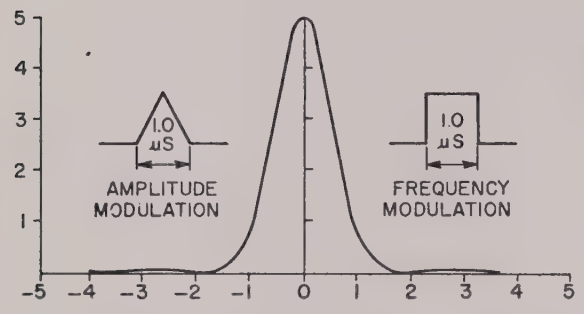


Figure 2-18. Symmetrical Triangular Voltage Pulse with no Frequency Modulation

2-27. Illustrated in figure 2-19 is an error-function voltage pulse with no frequency modulation. A transient of this type is unique in that the spectrum has the same form as the transient. The spectrum has no side lobes although it extends to plus or minus infinity. The portion of the spectrum beyond $f - f_0 = \pm 1.5$ mc/sec is negligible. The pulse shown is one having a spectrum of the same amplitude and half-power width as the one-microsecond rectangular pulse shown by the dashed lines. The shape of the center region of spectrum is almost identical with that of the rectangular pulse spectrum illustrated in figure 2-16.

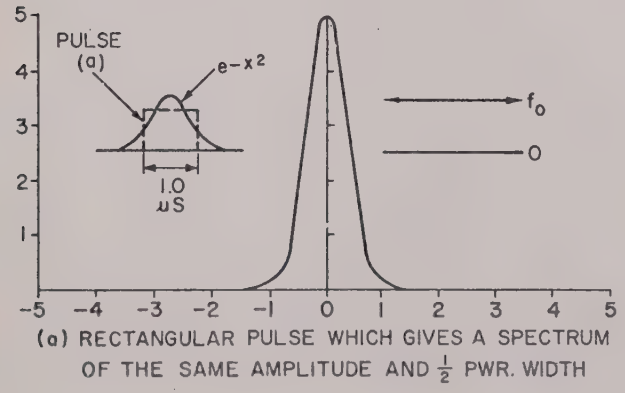


Figure 2-19. Error-Function Voltage Pulse with no Frequency Modulation.

2-28. Shown in figure 2-20, a, b and c are rectangular pulses with no amplitude modulation during the pulse, but with varying amounts of linear frequency modulation. The first effect of increasing the frequency modulation is to raise the minima which no longer are located at zero, as indicated by the spectrum of figure 2-20 a. Such action signifies that less energy is present in the center lobe. As the modulation increases, the secondary maxima rises until the center is reached, forming two peaks rather than one. This is shown by the spectrum of figure 2-20b. With higher modulation, more peaks can be formed as shown in figure 2-20c with the result that very little energy is located in the central region. All spectra in figure 2-20 are symmetrical and would be unchanged if the frequency modulation were reversed in polarity. Spectrum of figure 2-20a is classed as good, that of figure 2-20b is classed as fair and that of figure 2-20c is classed as poor

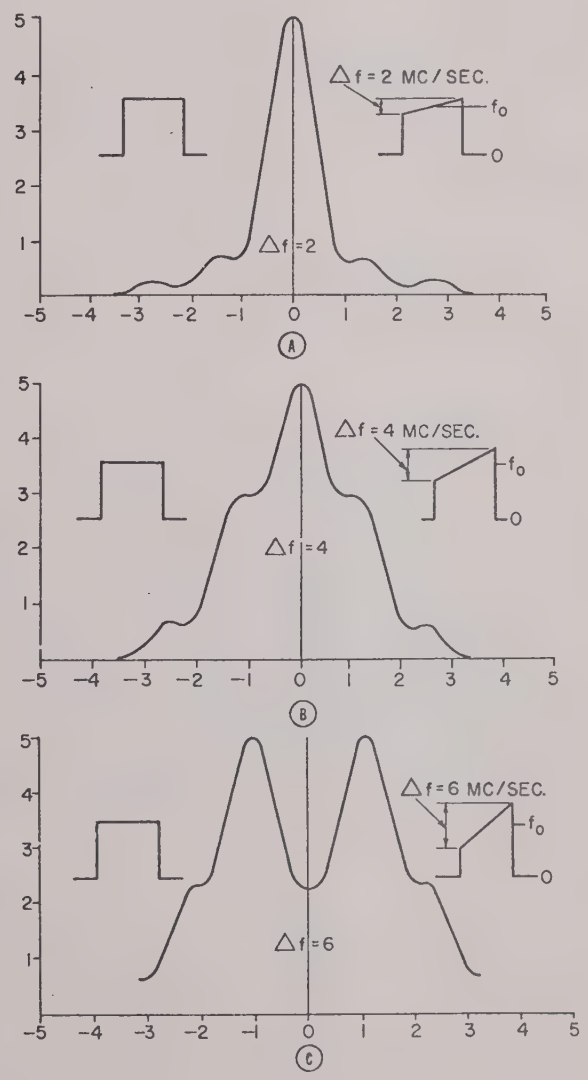


Figure 2-20. Rectangular Pulse with no Amplitude Modulation During the Pulse-Varying Amounts of Linear Frequency Modulation Present.

2-29. Figure 2-21 illustrates a linearly sloping pulse with ampliture modulation of 75 percent and no frequency modulation. This spectrum is very similar to that of the rectangular pulse shown in figure 2-16. The only difference is that the minima are not quite zero. The shape of the spectrum is not greatly altered even when the modulation is 200 percent (sawtooth form). Since there is no frequency modulation the spectrum is symmetrical. If the slope of the pulse were reversed the spectrum would be unchanged.

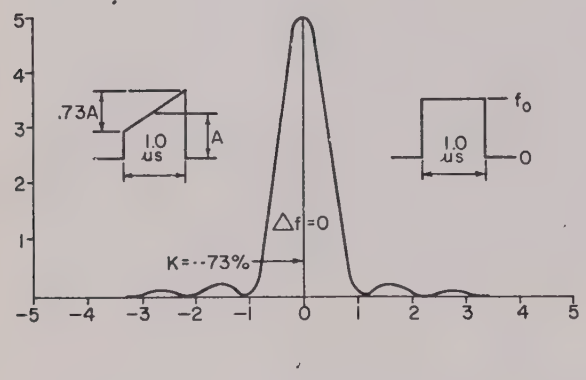


Figure 2-21. Linearly Sloped Pulse-
73 percent Amplitude Modulation
with no Frequency Modulation

2-30. Figure 2-22 indicates a linearly sloping pulse linearly frequency modulated. In the case of linear frequency modulation with no amplitude modulation the spectrum was symmetrical (see figure 2-20). In figure 2-22 the pulses are not symmetrical and the frequencies at which the pulse has higher amplitude are preferred to those frequencies at which the amplitude is low. The frequency is lowest where the amplitude is highest with the result that the spectrum is pushed in the direction of lower frequency.

2-31. Displayed in figure 2-23 is a trapezoidal pulse, trapezoidally frequency modulated. A large part of the pulse is rectangular so that a main lobe resembling that of a rectangular pulse is obtained. This is a form of spectrum which is commonly encountered from magnetrons and low-power pulsed oscillators. The almost complete absence of side lobes on one side and side lobes larger than usual on the other is typical. The frequency modulation causes a shift of the spectrum in the low-frequency direction but the effect is not as pronounced as it would be if the amplitude were unmodulated. The effective width of the pulse is between 0.5 and one microsecond as indicated by the position of the zeros.

2-32. From the spectra illustrated in figures 2-16, 2-17, 2-18, 2-19 and 2-21, observe that each of the spectra are symmetrical. Generally, in the absence of frequency modulation any r-f pulse will produce a symmetrical spectrum. When the frequency modulation is zero, changing the shape of the amplitude modulation, while keeping the effective pulse width constant, alters the relative sideband amplitudes but has

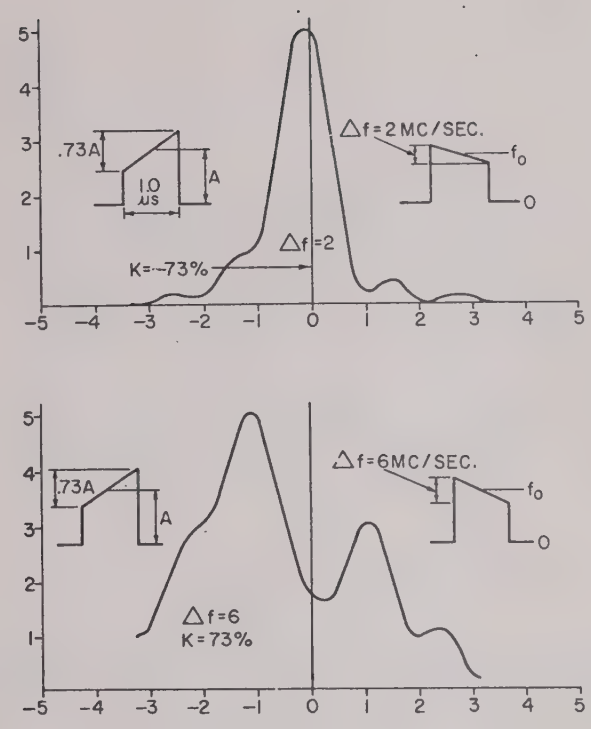


Figure 2-22. Linearly Scoped Pulse
with Linear Frequency Modulation

little effect on the main lobe. The spectra in figures 2-16, 2-18, 2-19 and 2-21 reveal this fact. From the spectra illustrated in figure 2-20 observe that in the case of no amplitude modulation a linear frequency modulation will result in a symmetrical spectrum. In general, with no amplitude modulation, a frequency modulation that is an odd function about the center of the pulse will produce a symmetrical spectrum. In fact, frequency modulation has the effect of broadening the spectrum and is usually more serious than amplitude modulation.

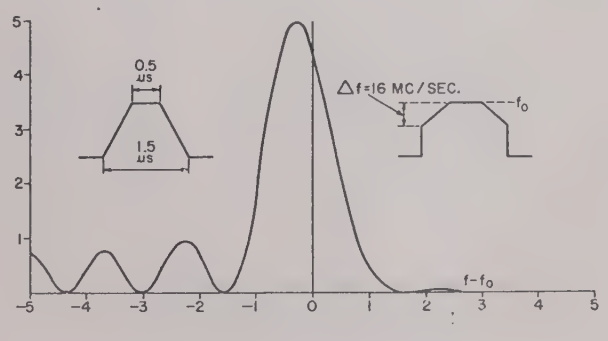


Figure 2-23. Trapezoidal Pulse
with Trapezoidal Frequency Modulation

SECTION III

OPERATING CHECKS AND ADJUSTMENTS

3-1. GENERAL.

3-2. This section contains information on equipment operating checks and adjustments which are considered necessary and which may be made by the operator prior to or during actual operation. Following the instructions given in this section will insure the operator that the equipment has been properly adjusted for use. The checks and adjustments to be made primarily require simple alignment of screwdriver-adjustment potentiometers. If the analyzer fails to function properly after the alignment procedures in this section are followed the operator should refer the trouble to maintenance personnel.

3-3. OPERATING CHECKS AND ADJUSTMENTS.

3-4. PLATE VOLTAGE SUPPLY. To check and adjust the plate voltage supply in the indicator unit (figure 3-1) follow the procedures given below:

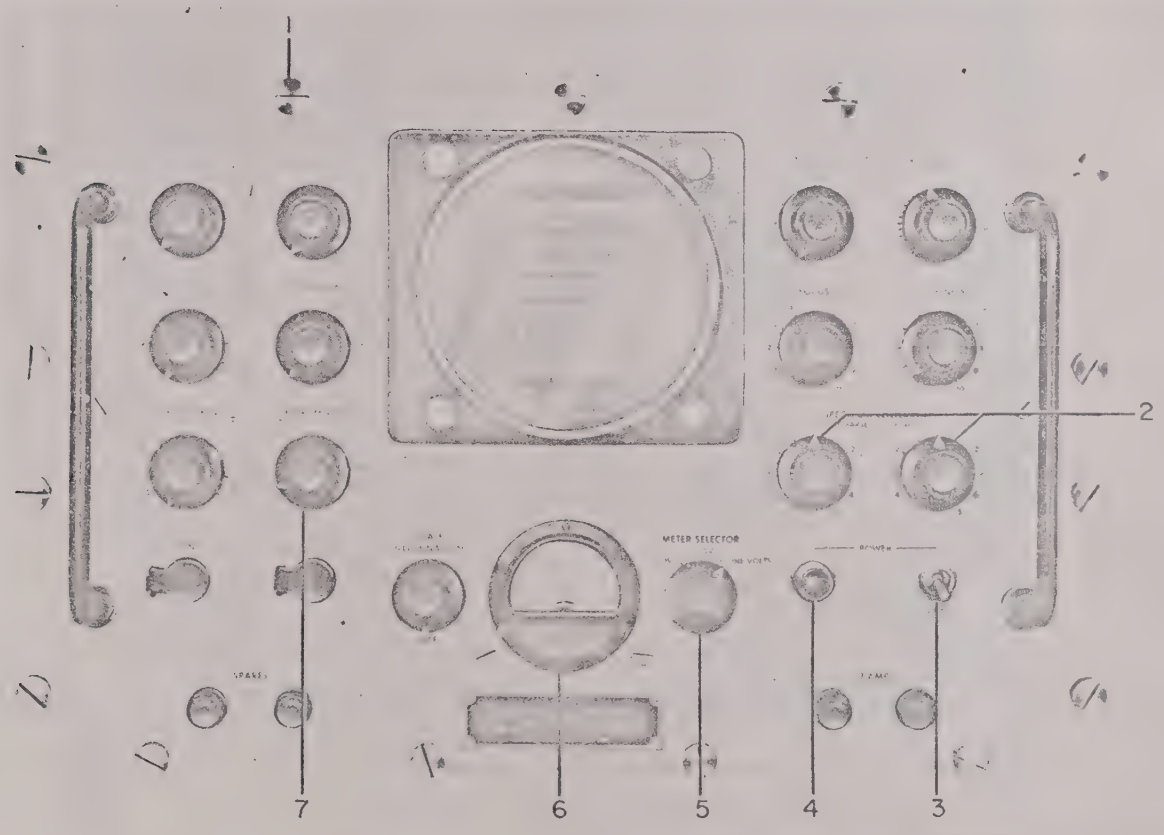
a. Plug the power cord into an external supply of 115 volts, 50 to 1000 cps, ac.

b. Throw on the "POWER" switch (3, figure 3-1). Observe the "POWER" indicator lamp (4). It must light.

c. Rotate the "METER SELECTOR" knob (5, figure 3-1) to "LINE VOLTS". Observe the indicated voltage reading on the voltmeter (6). It should read approximately 115 volts.

NOTE

Remove 8 shipping bolts at rear of cabinet in order to slide out drawers.



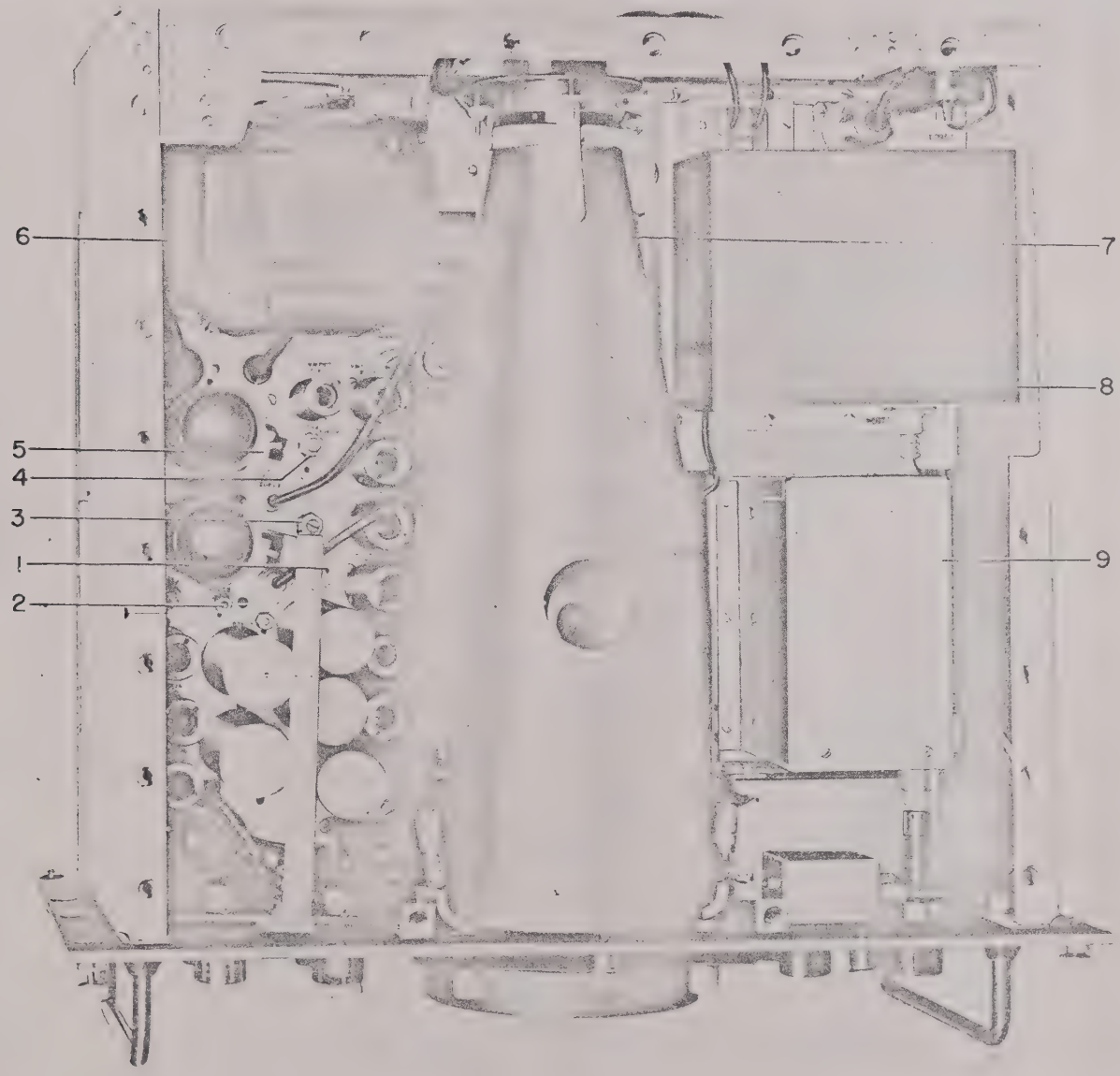
1. Indicator Unit Panel Screw
2. "SPECTRUM CENTERING" knobs
3. "POWER" switch
4. "POWER" indicator light
5. "METER SELECTOR" knob
6. Voltmeter indicator
7. "SPECTRUM WIDTH" knob

Figure 3-1. Pulse Analyzer Indicator, Front View

d. Rotate the "METER SELECTOR" knob (5, figure 3-1) to "+ 150 V". Observe the indicated voltage reading on the voltmeter (6). Voltmeter must read 150 volts ± 1 volt. If the reading varies substantially from this value, follow the instructions given in steps f and g in paragraph 3-4 for an additional check and necessary adjustments to be made.

e. Rotate the "METER SELECTOR" knob to "-150 V". Observe the indicated voltage reading on the voltmeter. Voltmeter (6) must read 150 volts ± 1 volt. If the reading varies substantially from this value, follow the instructions given in steps f and g in paragraph 3-4 for an additional check and necessary adjustments to be made.

f. Loosen the 15 panel screws (see figure 3-1) on the indicator unit and slide the drawer forward. Remove the top cover of the drawer to gain access to the top of the power supply chassis (6, figure 3-2). Place the positive test lead of a suitable voltmeter into the + 150-volt jack (5) colored red, on top of the power supply chassis. Place the negative test lead of the voltmeter to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1361 (4) requires adjustment. Refer to paragraph 3-4g for adjustment procedure. Place the negative test lead of the voltmeter into the -150-volt jack (1) colored white, and the positive test lead to chassis ground. Observe the voltmeter reading.



1. "-150 V" test jack
2. Potentiometer R1313
3. Potentiometer R1352
4. Potentiometer R1361
5. "+150 V" test jack
6. Power Supply and Video
7. Cathode Ray Tube
8. High Voltage Power Supply
9. Spectrum Calibrator

Figure 3-2. Pulse Analyzer Indicator, Top View

If the reading varies considerably from 150 volts, potentiometer R1352 (3) requires adjustment. Refer to paragraph 3-4g, for adjustment procedure.

g. Remove the voltmeter from the test jacks. With the "METER SELECTOR" switch (5, figure 3-1) on "+ 150 V", adjust potentiometer R1361 (4, figure 3-2) with a screwdriver until the voltmeter on the indicator unit panel reads 150 volts. With the "METER SELECTOR" switch on "-150 V", adjust potentiometer R1352 (3) with a screwdriver until the voltmeter (6, figure 3-1) reads 150 volts.

h. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

3-5. SPECTRUM CENTERING. The adjustment to be made for seectrum centering is performed only when the operator has determined that the "SPECTRUM CENTERING" controls (2, figure 3-1) cannot properly center the desired spectra viewed on the scope screen. To correct for spectrum centering perform the procedures as follows:

a. Loosen the 15 panel screws (shown in figure 3-1), on the indicator drawer and slide the drawer forward.

b. Set the "COARSE" and "FINE" controls ("SPECTRUM CENTERING") to their zero position. Adjust potentiometer R1016 ("CENTERING ADJUST"), shown in figure 3-3, with a screwdriver until the centering is restored on the scope screen. Allow setting to remain.

c. Carefully slide the drawer into the instrument case and secure all indicator panel screws.

3-6. SPECTRUM WIDTH. The adjustment to be made for spectrum width is performed only when the operator has encountered difficulty in obtaining the full 25-megacycle sweep by using the "SPECTRUM WIDTH" control (7, figure 3-1). The full range of the "SPECTRUM WIDTH" control is restored by performing the procedures as follows:

a. Loosen the 15 panel screws on the indicator drawer and slide the drawer forward. Remove the top cover of the drawer to gain access to the power supply chassis (6, figure 3-2).

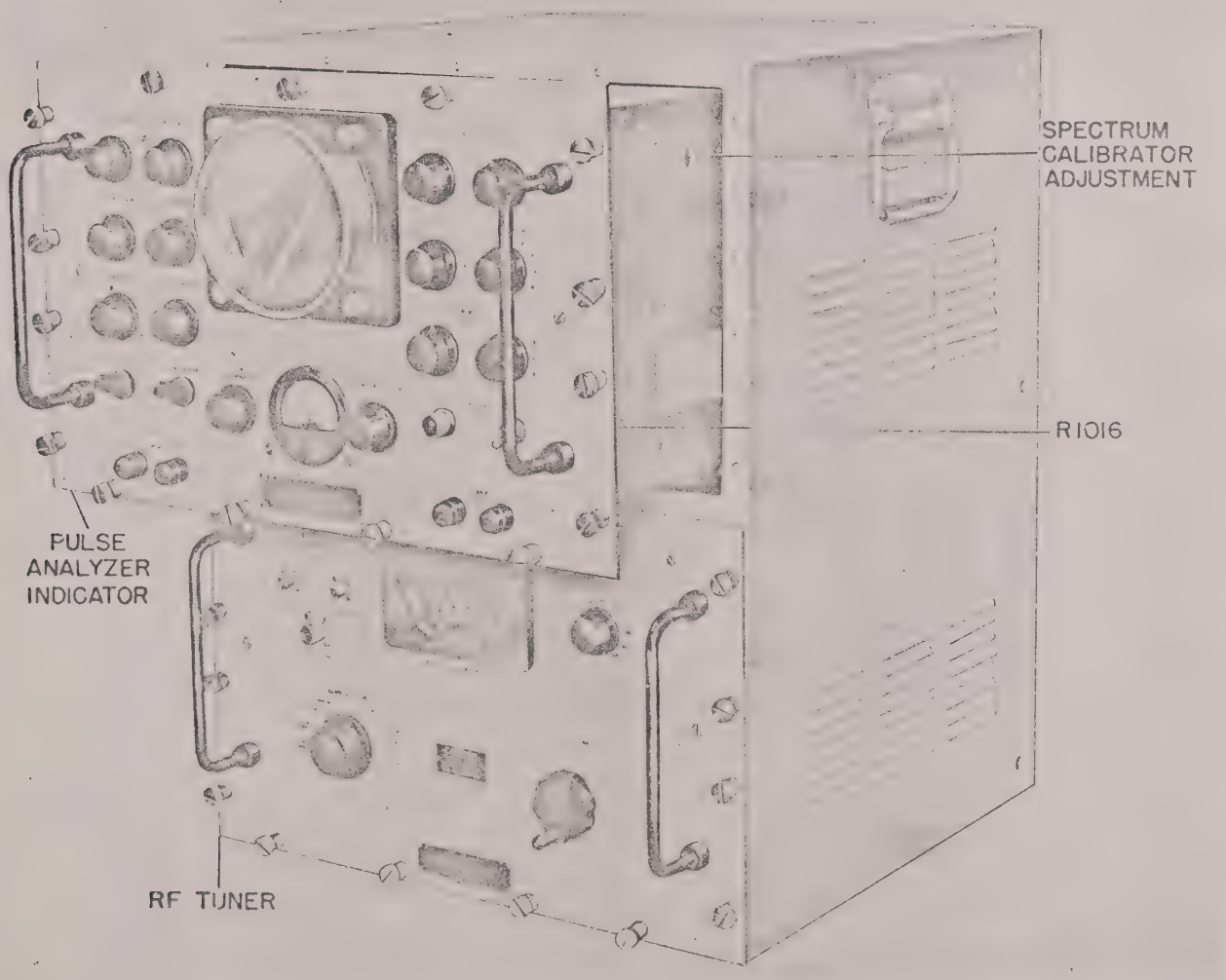


Figure 3-3. Spectrum Analyzer LA-17, Right Side

b. Adjust potentiometer R1313 (2, figure 3-2) with a screwdriver until the full range of the 25-megacycle sweep is restored on the scope screen. The "SPECTRUM WIDTH" control (7, figure 3-1) must be positioned to "25" during the adjustment procedure.

c. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case carefully and tighten all panel screws.

3-7. REPLACEMENT OF DETECTOR CRYSTALS.

3-8. In the event that replacement of detector crystals is required, any of the high-conductance germanium diodes listed in table VI may be used. Do not loosen the detector assembly when removing the cap.

TABLE VI. LIST OF DETECTOR CRYSTALS

Crystal Type	Manufacturer
2016A*	Hughes
T6G T8G T9G	Transitron
1N126	Hughes
1N98A 1N38A 1N69 1N70 1N81	Military Types

* Original equipment as supplied - preferred type.

TABLE VII. TUBE COMPLEMENT

COMPONENT	TUBE		FUNCTION	QUANTITY
	JAN NO.	REFERENCE SYMBOL		
1 MC I-F Amplifier	6AU6WA	V1205 V1206	Square Law Detector Square Law Detector	2
	5725/6ASGW	V1202	Mixer	1
	1/2 12AT7WA 1/2 12AT7WA 12AT7WA	V1201 V1204	Oscillator Frequency Doubler Phase Inverter	2
	6186/6AG5WA	V1203	Amplifier	1
64 MC I-F-Amplifier	6AN4	V1101	Mixer	1
	5654/6AK5WA	V1102 V1103 V1104 V1105	I-F Amplifier I-F Amplifier I-F Amplifier I-F Amplifier	4
160 MC I-F Amplifier	5654/6AK5WA	V2201 V2202 V2203 V2204 V2205 V2206 V2207 V2208 V2209 V2210	I-F Amplifier (Wideband) I-F Amplifier (Wideband) I-F Amplifier (Wideband) I-F Amplifier (Wideband) I-F Amplifier (Wideband) I-F Amplifier (Wideband) I-F Amplifier (Wideband) I-F Amplifier (Narrowband) I-F Amplifier (Narrowband) I-F Amplifier (Narrowband)	10
Sweep Frequency Generator	5654/6AK5W	V1501 V1505 V1506	Reactance Modulator Frequency Tripler Frequency Doubler	3
	6AH6	V1503 V1504	R-F Amplifier R-F Amplifier	5
	12AT7WA	V1502	Frequency Modulated Oscillator	1

TABLE VII. TUBE COMPLEMENT (cont)

COMPONENT	TUBE		FUNCTION	QUANTITY
	JÁN NO.	REFERENCE SYMBOL		
Oscillator 1 and 2	6AN4	V2504	Mixer	2
		V2502	Mixer	
	12AT7WA	V2503	Oscillator	1
	6AF4	V2501	Oscillator	1
Oscillator 3	5674	V2701	Oscillator	1
		Z2702	Mixer (Crystal)	1
Oscillator 4	2C36	V2901	Oscillator	1
		Z2702	Mixer (Crystal)	1
Power Supply and Video	12AU7	V1301	Multivbrator	
	1/2 12AU7	V1302	Sweep Generator	
	1/2 12AU7		FM Sweep Amplifier	4
	12AU7	V1305	Video Amplifier	
	1/2 12AU7		D.C. Restorer	
	1/2 12AU7	V1307	Intensifier Amplifier	
	12AT7WA	V1304	Video Amplifier	1
	6AU6WA	V1306	Intensifer Squaring	1
	6080	V1311	Series Regulator	2
			Series Regulator	
	OB2WA	V1310	Voltage Regulator	1
	12AX7	V1303	Sweep Amplifier	3
		V1309	Amplifier	
		V1312	Amplifier	
Spectrum Calibrator	12AT7WA	V1401	Oscillator	1
Pulse Analyzer Indicator	5CP1A	V1001	Cathode-Ray Tube (Display)	1

TABLE VIII. FUSE COMPLEMENT

COMPONENT	FUSE	RATING (amps)	TYPE NO.
Pulse Analyzer Indicator	F1001	3	3A-G
	F1002	3	3A-G
Power Supply	F1301	1	3A-G
	F1302	.25	3A-G

INFORMATION NOTE: When operating above 1000 mc, confusion may arise as to which band an observed frequency is actually on. To determine actual frequency, set the Spectrum Width control to 25 mc and rotate the tuning knob to move the signal from one edge of the screen to the other. On only one band will this correspond to 25 mc in calibration divisions. On higher bands, it will be 50 mc or 100 mc. On lower bands, 12-1/2 mc or 6-1/4 mc.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. This section contains a discussion on the theory of operation of the spectrum analyzer. The theory is described primarily for maintenance technicians equipped with experience on similar or related equipment. The basic principles and general theory of spectrum analyzers are not covered in this handbook since such information is included in textbooks on microwave measuring equipment. The description given in this handbook covers a treatment of circuitry operation characteristic to the particular equipment. With the aid of a functional block diagram, a description of circuit operation is given in the order of signal sequence. A detailed circuit analysis of each component is included and references are made to simplified electrical schematics.

4-3. FUNCTIONAL OPERATION OF THE ANALYZER.

4-4. Shown in figure 4-1 is a functional block diagram of the spectrum analyzer, indicating a signal flow. The spectrum analyzer, incorporating a narrowband receiver, is physically divided into two major components: the Pulse Analyzer Indicator and the R-F Tuner. The Pulse Analyzer Indicator is actually a complete spectrum analyzer which covers a frequency range from 145 to 175 megacycles. The R-F Tuner is primarily a frequency converter which changes the frequency range of 10 to 16,000 megacycles into a basic frequency range of 145 to 175 megacycles. The converted signal from the tuner unit is fed to the indicator unit where the time signal is changed to a frequency domain signal. This latter signal is that which is viewed on the cathode-ray tube screen on the panel of the indicator unit. The scope pattern produced is a plot indicating power vertically and frequency horizontally.

4-5. The incoming r-f signal may enter one of the four input receptacles on the tuner-drawer panel to accomodate the range of r-f frequencies to be analyzed. Each incoming signal is fed to one of four mixers (V2504, V2502 in oscillator 1 and 2, or the crystals in oscillator 3 and oscillator 4). A local oscillator (V2503, V2501, V2701, or V2901) generates a signal to beat against the incoming r-f signal in one of the mixers. The frequency of the local oscillator is made variable by manual use of the "TUNE" control on the panel of the tuner drawer. If the difference between the local oscillator frequency and the incoming r-f frequency is equal to the i-f frequency (160 mc), a signal is produced at the output of the mixer which is proportional to the r-f signal. The mixer output signal (the difference frequency, 160 mc) is then fed to the 160 mc i-f amplifier through the band selector switch S2202. This switch enables selection of one of the four mixer output signals, feeding it to either the wideband (25 mc) or the narrowband (5 mc) i-f amplifier.

4-6. The 160 megacycle i-f amplifier is used to perform the following functions: a) to wideband amplify the signal before the time-domain, frequency-domain conversion; b) to discriminate against the image frequency (352 mc) of the 64-megacycle oscillator; c) to provide isolation between the first mixer and the mixer V1101 in the 64-megacycle i-f amplifier (possessing sawtooth signal), thereby preventing sawtooth or frequency modulated signals from being present at the input receptacles on the tuner-drawer panel; d) to introduce the spectrum calibrator into the system.

4-7. The output of the i-f amplifier can be attenuated from zero to 60 db in 6 db steps by manual control of the i-f attenuator switch S2002 on the panel of the tuner-drawer panel. A signal from a frequency marker oscillator (spectrum calibrator) also feeds to the input of the 160-megacycle amplifier. The spectrum calibrator contains a tunable high frequency oscillator which produces a marker pip, adjustable in amplitude and frequency, on the scope screen. The marker pip permits frequency measurements of the scope pattern to be conveniently made.

4-8. The output signal of the 160-megacycle i-f amplifier is then fed from the tuner drawer to the indicator drawer where it is introduced into a 64-megacycle i-f amplifier together with the output of the sweep frequency generator. The 64-megacycle i-f amplifier is actually a second mixer which converts the 160-megacycle input to the low frequency of 64 megacycles. The output of the sweep frequency generator is centered about 224 megacycles and is frequency modulated by means of a sawtooth voltage. The frequency deviation is plus and minus 1/4 megacycle, minimum, to plus and minus 12-1/2 megacycles, maximum. In addition, the center frequency may be varied plus and minus 15 megacycles about the mean of 224 megacycles. The result is a series of 64-megacycle signals all occurring at different sequential times. These signals are then fed to the V1202 mixer in the one-megacycle i-f amplifier.

4-9. In the one-megacycle i-f amplifier a local crystal oscillator Y1201 generates a frequency of 32.5 megacycles which is fed to a frequency doubler V1201. The doubler doubles the 32.5-megacycle signal to produce an output of 65 megacycles which is fed to the input of mixer V1202. Mixer V1202 mixes the 65-megacycle signal and the 64-megacycle input signal to produce a difference frequency of one megacycle. The one-megacycle signal is then amplified by amplifier V1203, inverted by phase inverter V1204, and fed to a square law detector V1205. The detector

operates at a small signal level to produce an output voltage which is square law. The output of the detector is then fed to the video circuitry in the power supply and video unit. This unit contains sawtooth generating circuits, performing the dual purpose of modulating the sweep frequency generator as well as deflecting the cathode-ray beam.

4-10. DETAILED CIRCUIT ANALYSIS.

4-11. R-F TUNER.

4-12. OSCILLATORS 1 AND 2.

4-13. Shown in figure 4-2 is the electrical schematic of the two segments of the oscillators 1 and 2 unit. Each segment (oscillator 1 or oscillator 2) consists of an oscillator stage and a mixer stage. The oscillator 1 segment consists of a 12AT7WA (V2503) tube, in a push-pull oscillator circuit, generating frequencies between 170 and 320 megacycles. Also part of the oscillator 1 segment is the mixer stage using triode 6AN4 (V2504) which receives the 10-150 mc input signal and mixes it with the output signal from V2503. The oscillator 2 segment uses a 6AF4 (V2501) tube in a modified Colpitts oscillator, generating frequencies between 300 and 530 megacycles. Also part of the oscillator 2 segment is the mixer stage using triode 6AN4 (V2502) which receives the 150-350 mc input signal and mixes it with output signal from V2501.

4-14. All supply voltages to the operating stages of oscillator 1 and oscillator 2 originate from the power supply and video unit in the indicator drawer. Plate supply voltage (+150 V) is supplied to the multivibrator V2503 through inductances L2506, L2507 and L2510, and resistance R2508. Filament voltage (6.3 V ac) is supplied to V2503 through inductances L2511 and L2509. Plate voltage is applied to mixer V2504 through inductances L2506 and L2513 and resistances R2510 and R2514. Filament voltage is supplied to V2504 through inductances L2515 and T2503. For oscillator V2501, plate voltage is supplied through inductances L2501 and L2502 and resistance R2501. Filament voltage is applied through inductances L2508 and T2501. For mixer V2502, plate voltage is supplied through inductances L2501 and L2503 and resistances R2502 and R2507. Filament voltage is applied through inductances L2508 and R2502.

4-15. The V2501 oscillator stage is a modified version of the Colpitts Oscillator. The circuit is particularly suitable for frequency generation in the range of 300-500 mc, because feedback is obtained by the plate to cathode capacity of V2501 (6AF4). The 6AF4 tube contains sufficient plate to cathode capacity to obtain the required amount of feedback needed at the prescribed frequency range of operation. Capacitor C2506 (.22 mmfd) is used to increase the feedback from plate to cathode of V2501. Capacitor C2503 is made variable by manual control of the "TUNE" knob on the tuner-drawer panel. Varying this capacitance shifts the frequency of oscillation between 300 and 500 megacycles. The tune circuit of this oscillator is not a normal type of tuned circuit. A parallel wire transmission line is used to transform the impedance of the variable capacitor C2503 to a variable inductance at the tube terminals so that, as the capacitor is varied, tube V2501 "sees" a varying inductance. This inductance is tuned with the plate-grid capacity of V2501, capacitance C2505, the capacity presented by the tube due to the plate to cathode and grid to cathode capacitance, and the mutual conductance of the tube.

4-16. The output of oscillator V2501 is picked off at inductance L2502 which is magnetically coupled to inductance L2504. In this way, the output of V2501 is fed to the input of mixer V2502 by way of inductance L2502 and resistance R2506. The input signal to the analyzer, which passes through capacitor C2510, is combined with the oscillator output signal at the cathode of mixer V2502. The output signal in the plate circuit of mixer V2502 is 160 megacycles in frequency, and is then fed to the 160-megacycle i-f amplifier.

4-17. Both mixer stages in oscillator 1 and 2 unit perform the function of transforming the signal to be inspected into the frequency range of 145 to 175 megacycles. Triodes are employed primarily to reduce noise. To use triode mixers at such high frequencies, the grids must be grounded or oscillations will occur. In addition, the grounded grid mixers provide a low input impedance for matching the impedance of the 50-ohm systems required. The plate circuits of both mixers are double tuned in order to obtain the wide band width required. The chokes in the filament circuits of both mixers are used to keep the cathodes further off the ground.

4-18. The V2503 oscillator stage is a relaxation oscillator. This push-pull oscillator is very suitable for generating frequencies in the range of 170-320 megacycles. Capacitance C2517 is made variable by manual control of the "TUNE" knob on the tune-drawer panel. Varying this capacitance causes oscillations to occur between 170 and 320 megacycles. The output of the oscillator V2503 is picked off on inductance L2507 which is magnetically coupled to inductance L2512. In this manner, the output of the oscillator is fed to the cathode of mixer V2504, through inductance L2512. The input signal to the analyzer, which passes through capacitor C2510, is combined with the oscillator output signal at the cathode of mixer V2504. The output signal in the plate circuit of mixer V2504 is 160 megacycles in frequency and is then fed to the 160-megacycle i-f amplifier.

4-19. OSCILLATOR 3 AND OSCILLATOR 4.

4-20. The theory of operation of both oscillator 3 and oscillator 4 are similar. Therefore, only oscillator 4 will be explained. Oscillator 4 is used as the local oscillator for the spectrum analyzer range of 1000 mc to 16,000 mc. The oscillator circuit shown in figure 4-3 employs a uhf type triode 2C36 (V2901) operating with an external resonant cavity. The entire assembly includes a pair of concentric transmission lines built up mechanically of three metal cylinders mounted coaxially one within the other. The innermost cylinder is in contact with the cathode, the center cylinder is coupled through an air capacitor of low value to the grid, and the outer cylinder is similarly coupled to

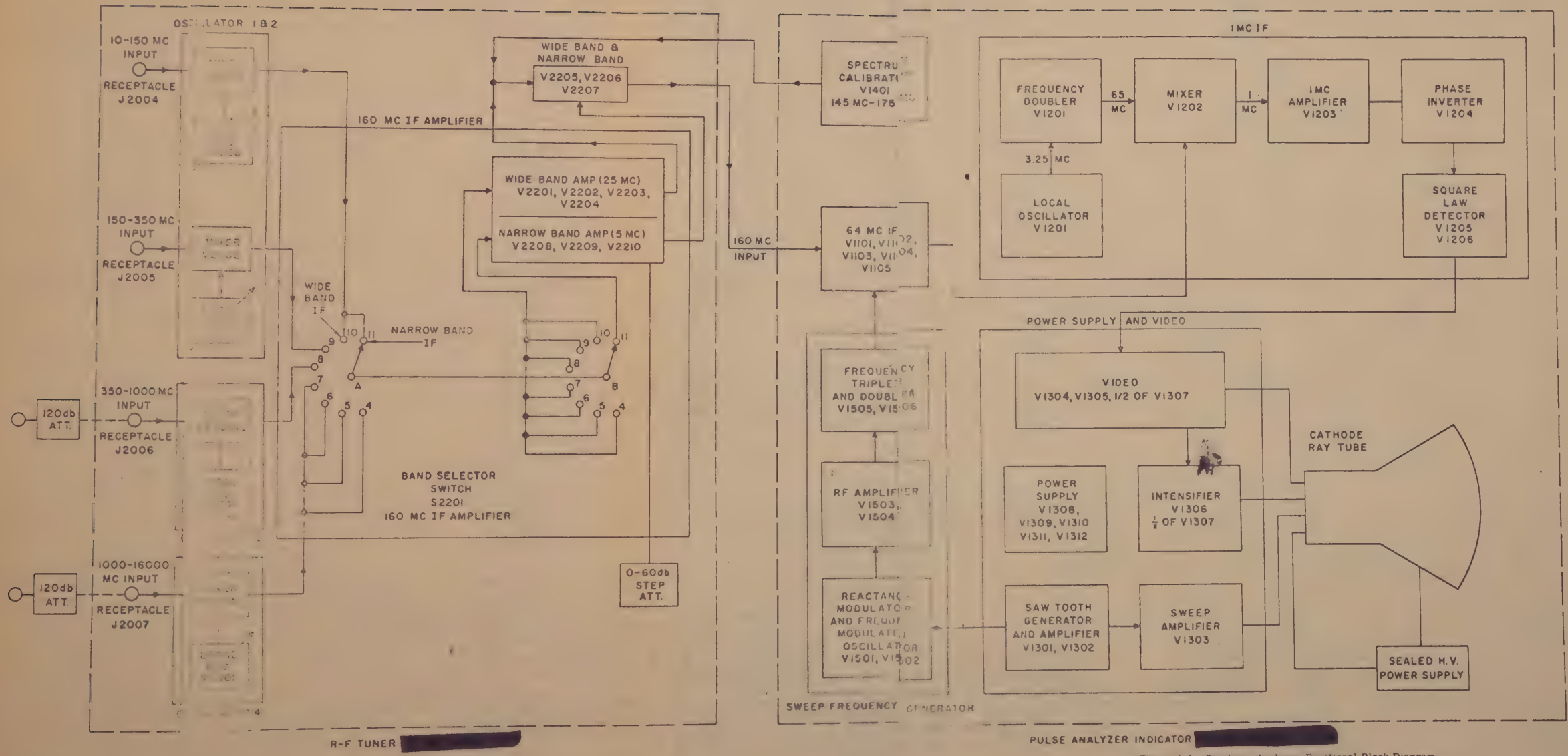


Figure 4-1. Spectrum Analyzer Functional Block Diagram

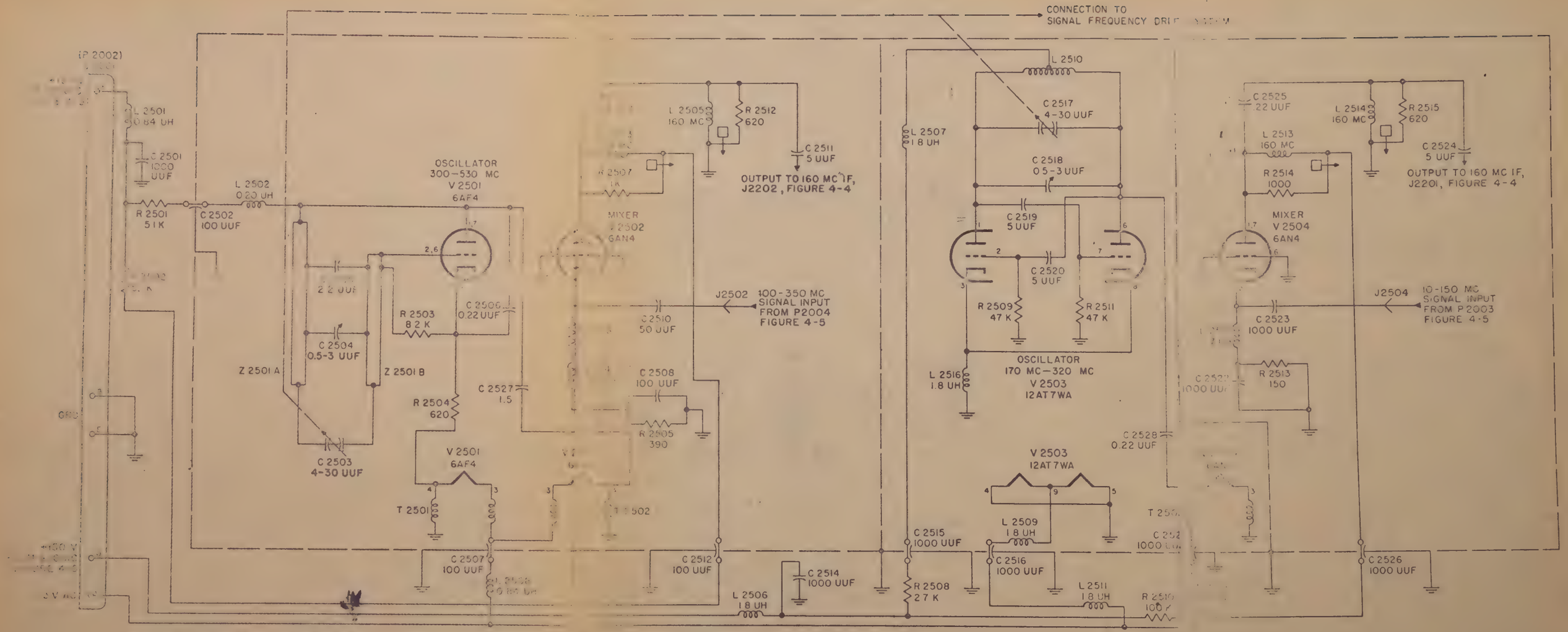


Figure 4-2. Oscillators 1 and 2 Schematic Diagram

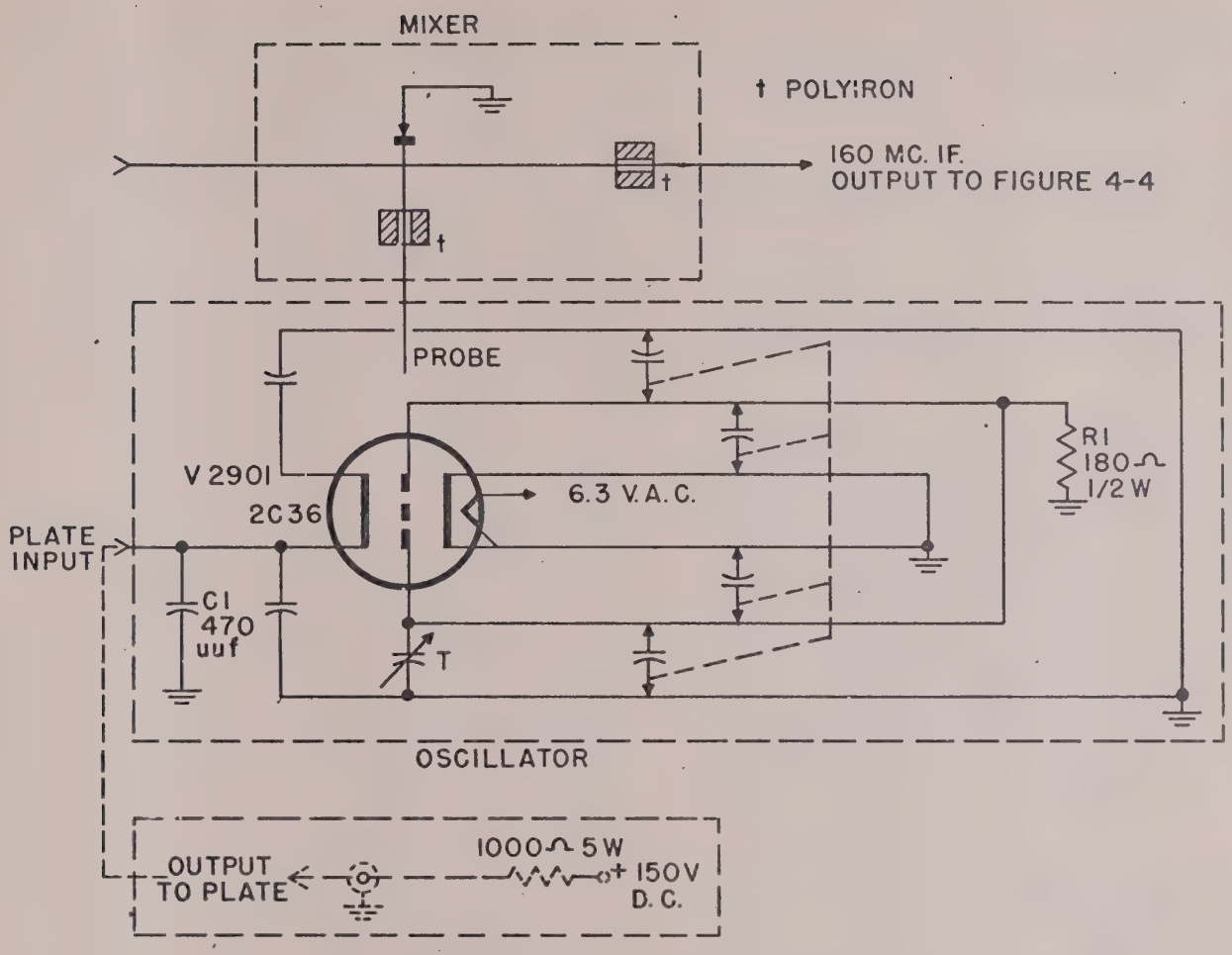


Figure 4-3. Oscillator 4, Schematic Diagram

the plate. The input ends of both transmission lines are effectively open due to the small coupling and the series tube capacitances.

4-21. The outer concentric line built up of the two outer cylinders constitutes the resonant cavity. This line is short-circuited at a point one-quarter wavelength from the input, electrically forming the equivalent of a parallel resonant circuit between the plate and the grid. The inner concentric line, which is short-circuited slightly beyond the quarter wavepoint, presents a capacitive reactance between the grid and the cathode. A screw, set into the outer cylinder, passed through a feedback hole in the center cylinder, and extending down into the grid-cathode transmission line, introduces a small capacitance between the plate and the cathode. A loading slug mounted on the inner wall of the grid cylinder, in close proximity to the cathode cylinder, tends to suppress higher mode oscillations. In addition to the parallel resonant circuit capacitively coupled between the plate and the grid, the complete oscillator circuit electrically includes two capacitances connected in series between the plate and grid, with the cathode between them. Electrically, the oscillator is equivalent to the Colpitts Oscillator circuit.

4-22. The oscillator frequency is determined by the resonant frequency of the plate line. By changing the position of the plunger contact, which shorts the line, the resonant frequency of the line also changes. A similar shorting contact is located in the grid-cathode line. Both shorting contact plungers are secured to the same geared-drive mechanism so that both are moved in unison by the "TUNE" control, which varies the oscillator frequency throughout its range.

4-23. 160-MC I-F AMPLIFIER.

4-24. Shown in Figure 4-4 is the electrical schematic of the 160-mc i-f amplifier. The amplifier consists of a narrowband (5 mc) i-f amplification section and a wideband (25 mc) i-f amplification section. The narrowband section is made up of three (triple) i-f stages V2208, V2209, and V2210. The wideband section is made up of six (two triples) i-f stages V2201, V2202, V2203, V2204, V2205, and V2206, plus a seventh stage, V2207, which is a cathode follower.

4-25. Plate voltage (Narrow B+, 150 V) is supplied to the triple in the narrowband section by way of inductances L2226, L2224, L2223, L2221, and L2220. Plate voltage (Wide B+, 150 V) is applied to the first

four i-f stages of the wideband section V2201, V2202, V2203, and V2204 by way of inductances L2212, L2209, L2206, and L2203. Plate voltage (+150 V) is supplied to stages V2205, V2206, and V2207 through inductances L2217, L2215 and resistances R2226, R2222, and R2218. The supply of plate voltage is split in such a manner to permit operation of only such stages as are selected by means of the "BAND SELECTOR" switch S2001 (explained in paragraph 4-32). The band switch arrangement in the tuner drawer permits the removal of Wide B+ from stages V2201, V2202, V2203, and V2204 when the switch is on "10-150 MCS NARROW" and the removal of Narrow B+ from stages V2208, V2209, and V2210 when the switch is on "10-150 MCS WIDE". In addition, such switching operation does not affect the supply of plate voltage to stages V2205, V2206, and V2207, which also handle the frequency marker signal from the spectrum calibrator.

4-26. The output signal from one of the four mixer stages (160 mcs) enters the input of the 160-mc i-f amplifier through selector switch S2201 (A or B deck of "BAND SELECTOR" switch). Shown in the schematic of figure 4-3 is a table revealing the position of the "BAND SELECTOR" switch S2201 and the corresponding contacts connected for each position. With the switch on "10-150 MCS NARROW", the output of mixer V2504 will feed to the input of the narrowband i-f amplifier V2208 (by way of capacitor C2229 and inductance L2238) because contact 11 of switch S2201A connects with contact 12. Similarly, with the switch on "10-150 MCS WIDE", the output of mixer V2504 will feed to the input of the wideband i-f amplifier V2201 (by way of inductance L2202) because contact 10 of switch S2201B connects with contact 12. On all remaining positions of the "BAND SELECTOR" switch, either the output of mixer V2502, the crystal mixer in oscillator 3, or the crystal mixer in oscillator 4 will feed to the input of the wideband i-f amplifier V2201.

4-27. All the tubes used in the 160-mc i-f amplifier are type 6AK5 possessing a gold-plated grid to obtain maximum gain with a minimum of noise. All stages are tuned with minimum capacity in order to obtain maximum gain. Each of the pentode stages is a typical r-f pentode amplifier, the only difference being the addition of a resistance (22 ohms) between pins 2 and 7. In addition, the first i-f amplifier stages (V2201 and V2208) in both the narrowband section and the wideband section contain a 51-ohm cathode resistor (R2204 and R2233) and a 39,000-ohm screen resistor (R2201 and R2231) to provide minimum noise generation.

4-28. The input wideband signal to the wideband section is amplified by four i-f stages V2201, V2202, V2203, and V2204, the signal being amplified further by i-f stages V2205 and V2206. The signal is then fed to the cathode-follower stage V2207 which is the output of the 160-mc i-f amplifier. The output signal of the cathode followers then fed to the 64-mc i-f amplifier in the indicator drawer by way of the interdrawer cable. The cathode-follower stage V2207 is utilized to approximately match the output impedance of the 160-mc i-f amplifier with the interdrawer cable, which is an appreciable number of wavelengths long. The 25-mc bandwidth in the 160-mc i-f amplifier unit is obtained by the use of two staggered triples, each triple being approximately 30 megacycles wide. In cascade, the overall bandwidth reduces to the range of 25 to 30 megacycles.

4-29. The narrowband input signal to the narrowband section is amplified by three i-f stages V2208, V2209, and V2210. The output from stage V2210 is fed to the control grid of tube V2206, through capacitor C2238, and amplified further. The output of amplifier V2206 is then fed to the cathode follower V2207. The 5-mc bandwidth is obtained by preceding the second 25-mc triple (stage V2206) with two synchronously tuned stages (V2208 and V2209).

4-30. The output attenuation of the 160-mc i-f amplifier is made controllable by use of the "IF ATTENUATION - DB" switch on the tuner-drawer panel. By manipulating the switch, the cathode resistance of the first triplet (V2201, V2202, V2203, and V2204) in the wideband side, and the first three tubes (V2208, V2209, and V2210) in the narrowband side, is made to vary. The cathode resistance of the first triplet, and of the first three tubes in the narrowband side, are connected in series with resistors on the attenuator switch S2002A and B on the tuner-drawer panel. Effectively, the cathode resistance is increased by inserting increased resistance values in series with the zero db resistance. On the attenuator switch S2002 is mounted a number of resistors arranged in such a manner to permit the addition of resistance to the cathode resistance at each progressive step position.

4-31. The frequency marker signal from the spectrum calibrator enters the 160-mc i-f amplifier through capacitor C2244 and is fed to the control grid of tube V2205. The signal is introduced into the second triple so that it appears with the same relative amplification for both the narrowband and wideband signals, and so that it can be swept flatly over the full 25-mc bandwidth. Introduction of the frequency marker signal into the second triple also allows the signal to be the same amplitude regardless of the position of attenuator switch S2002.

4-32. FUNCTIONAL OPERATION OF R-F TUNER CONTROLS. Shown in figure 4-5 is a schematic of the tuner drawer, indicating the electrical layout of the controls on the drawer panel. The controls shown schematically are the "BAND SELECTOR" switch S2001 (decks A, B and C) and the "IF ATTENUATION - DB" switch S2002 (decks A and B). The schematic also contains a table revealing the position of the "BAND SELECTOR" switch S2001 and the corresponding contacts of each deck connected for each switch position. The B deck of the selector switch is used to transfer the +150 volts (plate voltage supply) from the output of the power supply and video unit to the narrowband stages and the wideband stages of the 160-mc i-f amplifier The C deck of the selector switch is used to transfer the +150 volts (plate voltage supply) from the output of the power supply and video unit to oscillator 1 and 2, oscillator 3, and oscillator 4. The A deck of the selector switch is used to transfer the 6.3-volt filament voltage from the power supply to the sixteen indicator lamps I2001 to I2016. The lamps

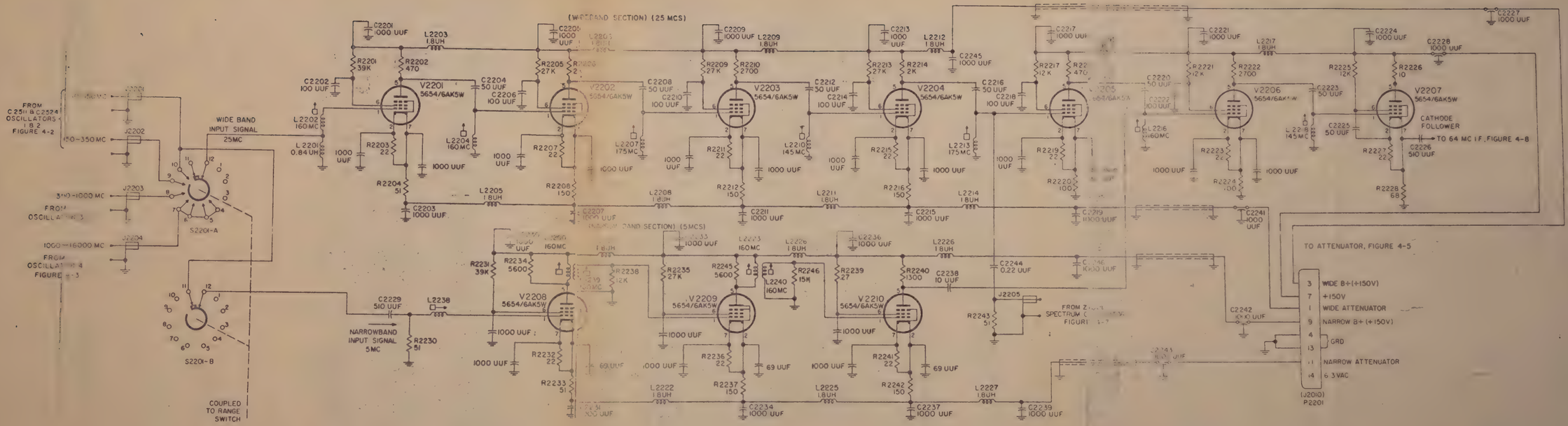


Figure 4-4. 160-MC I-F Amplifier Simplified Schematic

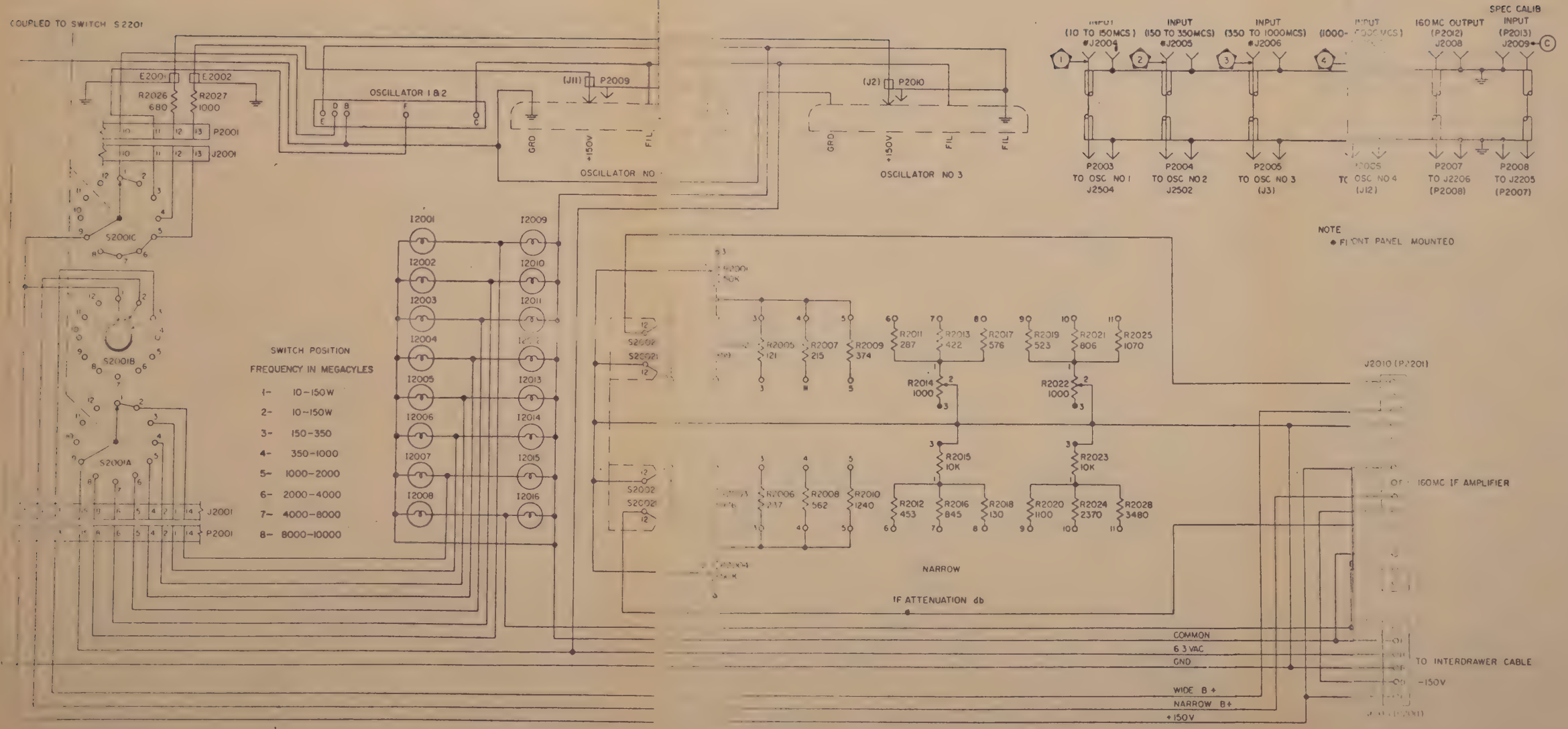


Figure 4-5. R-F Tuner Controls Schematic Diagram

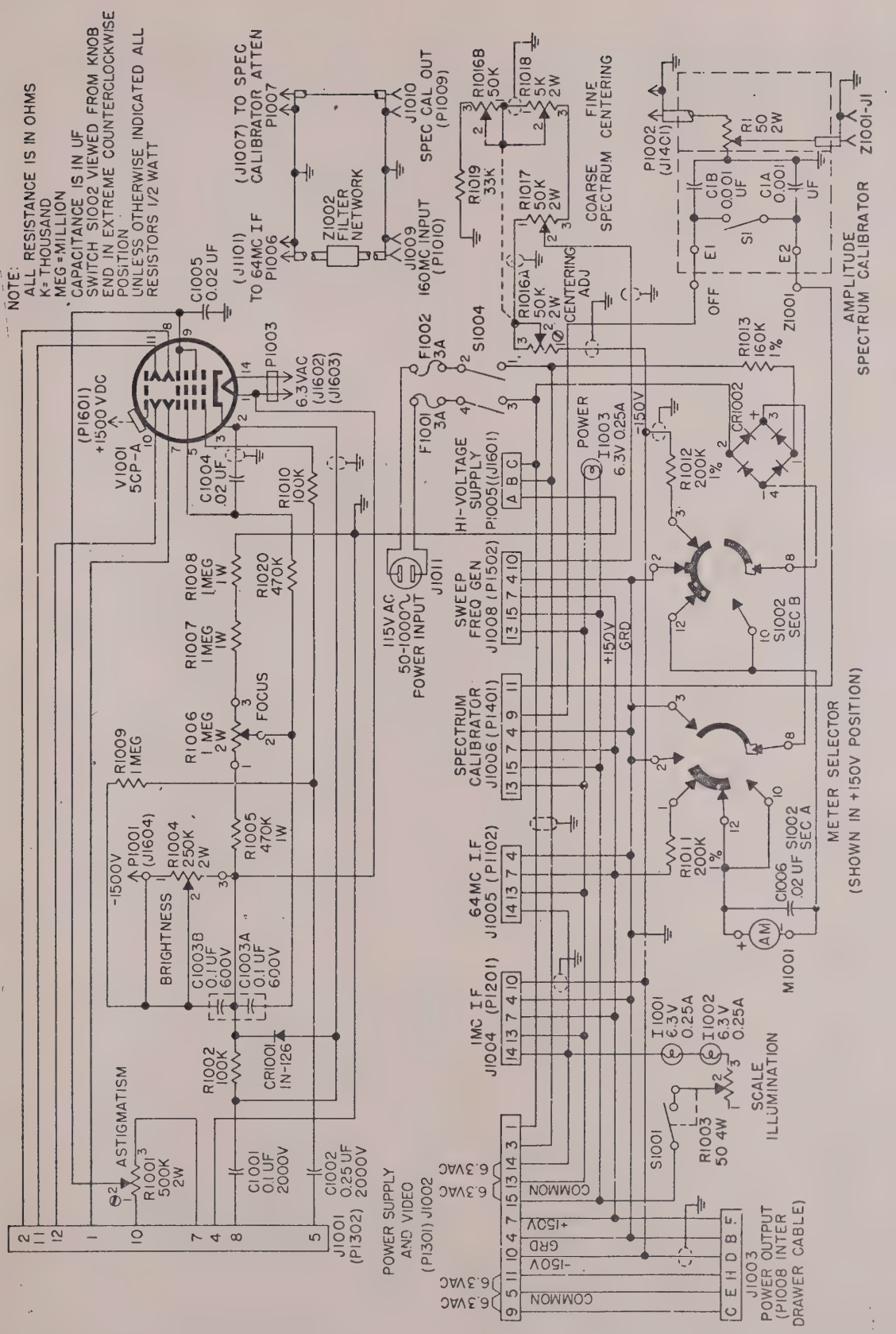


Figure 4-6. Indicator Drawer, Schematic Diagram

are used to illuminate the selected frequency scale to be read on the "FREQUENCY IN MEGACYCLES" dial. The "IF ATTENUATION - DB" switch S2002 controls the output attentuation of the 160-mc i-f amplifier. As the switch is rotated clockwise, resistances are effectively added to the cathode circuit resistance of the wideband and narrowband stages of the 160-mc i-f amplifier, the A deck of switch S2002 providing wide attenuation, and the B deck providing narrow attenuation. The 25 resistors (R2001 to R2025) are mounted on the attenuator switch S2002 and are arranged functionally to permit the addition of series resistance to the cathode circuit resistance at each progressive step position of the switch knob. The attenuation is increased in steps of 6 db, the range of the switch being fron 0 to 60 db.

4-33. PULSE ANALYZER INDICATOR.

4-34. PRIMARY POWER DISTRIBUTION.

4-35. Shown in figure 4-6 is a schematic showing power distribution to the analyzer. Input power, 115 volts, 50-1000 cycles per second, is supplied through two fuses F1001 and F1002. The "POWER" switch S1004, shown in the open ("OFF") position, is used to control the input power to the equipment. With the power switch closed, 115 volts are fed to the high-voltage power supply, and the power supply and video unit. The power supply and video unit produces three output voltages (+150 V dc, -150 V dc, and 6.3 V ac). The three output voltages are fed to the 160-mc i-f amplifier, 1-mc i-f amplifier, 64-mc i-f amplifier, spectrum calibrator, and the sweep frequency oscillator. The +150-V d-c output is plate supply voltage and the 6.3-V a-c output is filament supply voltage. In addition, the 6.3-V a-c supply is used as a source for the indicator lamp I1003 which, when lit, indicates to the operator that power is being delivered to the instrument from an external source. The scale-illumination indicators I1001 and I1002 also use the 6.3-V a-c supply as a source, the indicators being controlled by use of the switch-potentiometer control ("SCALE ILLUMINATION") S1001 and R1003. The lamps illuminate the reticule in front of the cathode-ray tube screen.

4-36. The meter selector circuit consists of milliammeter M1001, "METER SELECTOR" switch S1002A and B, resistors R1011 and R1012, selenium rectifier CR1002, and resistor R1013. This circuit is used to check the power supply and video output voltages (+150 V dc and -150 V dc), also enabling a check to be made on the presence of line voltage (115 V ac). The milliammeter M1001 functions as a voltmeter when the multipliers R1011, R1012, and R1013 are placed in series with the meter. The resistances are placed in series with the milliammeter by use of selector switch S1001. Shown in the schematic is a table revealing the position of the "METER SELECTOR" switch and the corresponding contacts connected for each switch position. Selector switch S1002 is shown in the schematic as being in the "+150 V" position. In this position, resistor R1011 is placed in series with the milliammeter so that the meter reads 150 volts dc with respect to ground. With selector switch S1002 in the "-150 V" position, the positive side of the milliammeter becomes grounded through the A deck, while resistor R1012 is placed in series with the meter through the B deck. With meter M1001 grounded as such, the positive side of the meter still remains more positive than the negative side so that, effectively, the meter will read the voltage between the -150 volts line and ground. In the "LINE VOLTS" position, the meter M1001 will read 115 volts dc, the rectified input voltage, 115 volts ac. In this position, the a-c voltage is rectified by selenium rectifier CR1002, and resistor R1013 is placed in series with the meter.

4-37. SPECTRUM CALIBRATOR.

4-38. Shown in figure 4-7 is a simplified schematic of the spectrum calibrator. The spectrum calibrator is a push-pull oscillator, operating in the frequency range of 145 to 175 megacycles. A dual triode type tube 12AT7 (V1401) is used. The circuitry of this oscillator is essentially the same as oscillator 1, except that the spectrum calibrator oscillator operates at a reduced frequency range. Since the oscillator is push-pull, it is quite stable for the specified operating frequency range, the frequency stability falling within 10 megacycles per second per hour.

4-39. The spectrum calibrator circuitry is physically divided into two assemblies: the attenuator unit Z1001 and the spectrum calibrator unit. The sealed attenuator unit is mounted in back of the front panel of the indicator drawer and contains a switch-potentiometer control S1 and R1. The remaining components of the spectrum calibrator circuitry shown on the schematic are located in the spectrum calibrator unit. The attenuator unit Z1001 performs two functions: to control the plate supply voltage from the power supply and video unit to the oscillator, and to control the output attenuation of the oscillator. With switch S1003 in the on position ("CLOSED"), the plate supply input voltage (+150 V) to the spectrum calibrator is fed to inductances L1401, L1403, and L1404. The potentiometer R1014 ("AMPLITUDE") is used to vary the output signal of the oscillator which is fed to the 160-mc i-f amplifier in the tuner drawer. The spectrum calibrator unit is interlocked between the wiring leads of switch S1. This is done so that plate supply voltage is removed from the switch terminals when the spectrum calibrator unit is not in place.

4-40. The oscillator tank circuit consists of capacitors C1403, C1404, and inductance L1404. The output of the oscillator is obtained by an inductance L1405 (possessing a small loop) which is magnetically coupled to the oscillator tank circuit. Since the oscillator output is quite strong, it passes through a T-pad of resistors (R1405, R1406, and R1407) and then to the attenuator unit Z1001. The variable capacitor C1404 is a trimmer capacitor used to account for changes in replacement of tube V1401. Only a small portion of capacitor C1403 is used due to the small frequency range of the oscillator. Capacitor C1403 is varied by use of the "SPECTRUM CALIBRATOR" frequency control ("FREQUENCY") on the panel of the indicator drawer. Capacitor C1403 is shafted to this control through a waveguide below cutoff. The shaft is an insulated material inside a hollow tube which also acts as a bearing or bushing. The attenuation of this tube is over 100 db at the frequency range of the spectrum

calibrator. The spectrum calibrator signal is introduced into the second triple of the 160-mc i-f amplifier so that it is available for operation, regardless of whether wide or narrow position is used, and regardless at which position the step-attenuator control "IF ATTENUATION - DB" is set.

4-41. 64-MC I-F AMPLIFIER.

4-42. Shown in figure 4-8 is a simplified schematic of the mixer stage V1101, which is the input stage of the 64-mc i-f amplifier. The remaining stages of the 64-mc amplifier, which consists of four i-f amplifier stages V1102, V1103, V1104, and V1105 are illustrated in figure 4-8 and discussed in subsequent paragraphs. The two input signals to the triode mixer V1101 are derived from the sweep frequency generator and the 160-mc i-f amplifier. The signal from the sweep frequency generator and the 160-mc i-f amplifier. The signal from the sweep frequency generator is fed to the grid of mixer V1101, while the signal from the 160-mc i-f amplifier is fed to the mixer cathode. The two signals are combined in the triode and the output appears in the tank circuit L1101, C1103, and C1125, which is tuned to 64 megacycles. The 64-mc output signal is then fed to the control grid of the first i-f amplifier stage V1102.

4-43. The triode mixer is used to reduce noise, thereby increasing the sensitivity. It must be grounded grid since grounded cathode triodes will oscillate at 64 megacycles. The triode mixer functionally operates under grounded-grid conditions at the signal frequency of 160 megacycles, even though the 224-mc signal from the sweep frequency generator is injected into the grid. Due to the tuned-circuit output stage of the sweep frequency generator, the output signal of this generator is fed at a low impedance level to

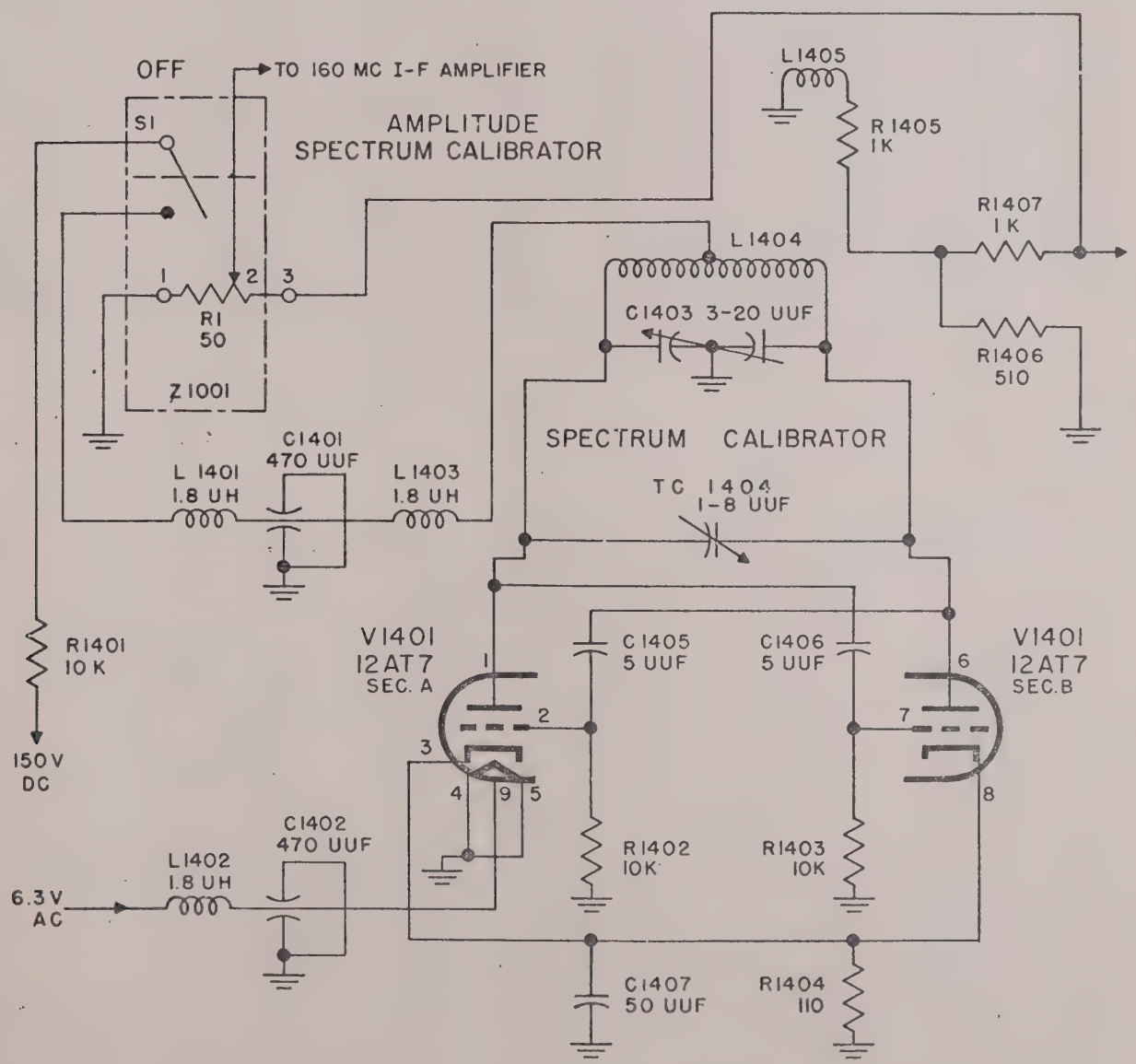


Figure 4-7. Spectrum Calibrator, Simplified Schematic

mixer stage V1101. The impedance at 160 megacycles is exceptionally low. The values of the cathode resistor R1102 and the plate-dropping resistor R1104 in the mixer provide good mixing operation for use with the output levels of the sweep frequency generator.

4-44. Shown in figure 4-9 is a simplified schematic of the amplifier stages in the 64-mc i-f amplifier. The sensitivity of the 64-mc i-f amplifier unit under normal operating conditions is about 4.5 to 6 microvolts for a signal-to-noise ratio of two to one when the input signal is 160 megacycles. The bandwidth of the amplifier is in the order of 200 kilocycles. Each of the four i-f amplifier stages, incorporating pentode type tubes, amplify the 64-mc input signal. The output signal in the last i-f amplifier stage V1105 is then fed to the mixer stage V1202 in the 1-mc i-f amplifier. The output of each amplifier stage contains a tuned circuit similar to the tuned circuit used in the output of the mixer V1101. The Q of the tuned circuit in the plate of the mixer is lower than the Q of the tuned circuit in the plate of the i-f amplifiers. This is due to the smaller plate resistance of the V1101 triode. All coils in the output of each i-f amplifier stage are tapped to reduce loading on the tuned circuits due to the input conductance of the following tube.

4-45. The first pentode amplifier stage V1102 contains a 51-ohm cathode resistance R1107 and a 39,000-ohm screen-dropping resistance R1108 in order to place the equivalent noise resistance of this tube at a minimum. The capacitors C1108, C1112, C1116, and C1120 are 510 mmfd in value, being used as bypass capacitors. The 100-ohm resistors R1109, R1114, R1119, and R1124 prevent the formation of a high-Q resonant circuit, which might result between each of the capacitors just mentioned and the corresponding B+ bypass capacitors C1110, C1114, C1118, and C1121. The second amplifier stage V1103 contains a variable resistor R1112 for gain control. Clockwise rotation of the shaft of this gain control (from the top of the chassis) increases the gain by decreasing cathode resistance and thus the bias. The screen resistor R1113 prevents the 140-volt rating of tube V1103 from being exceeded for various settings of the gain control R1112. The third amplifier stage V1104 contains a larger cathode resistance R1117 in order to decrease the gain of this stage for the purpose of cutting down overall regeneration.

4-46. The 10-ohm resistors R1106 and R1121 in the plate circuit of tube stage V1101 and tube stage V1105, respectively, are anti-parasitic resistors. The two resistors are also used to cut down regeneration due to extra loading on the respective coils L1103 and T1102. The tuned circuit in the plate of amplifier V1105 contains a different coil-capacitor combination than the previous stages. The tuned circuit of amplifier V1105 is used primarily for impedance matching, not contributing much to the selectivity of the amplifier. Note that the 64-mc i-f amplifiers make use of a plexicon tube socket which contains built-in bypass capacitors. The capacitors are marked with an asterisk on the schematic, figure 4-9, and are used as bypass capacitors for the cathode, screen, and heater elements of each amplifier tube. The bandwidth of the amplifier is in the order of 200 kilocycles.

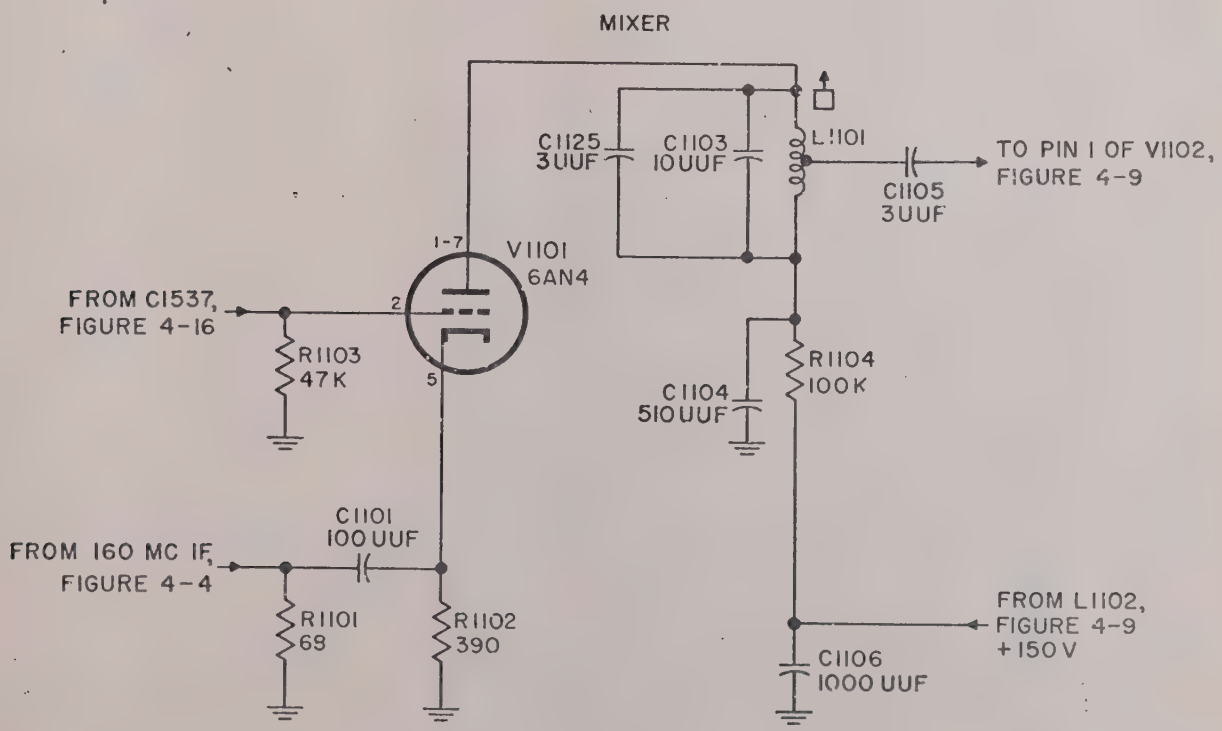


Figure 4-8. Mixer Stage V1101, 64 MC I-F Amplifier, Simplified Schematic

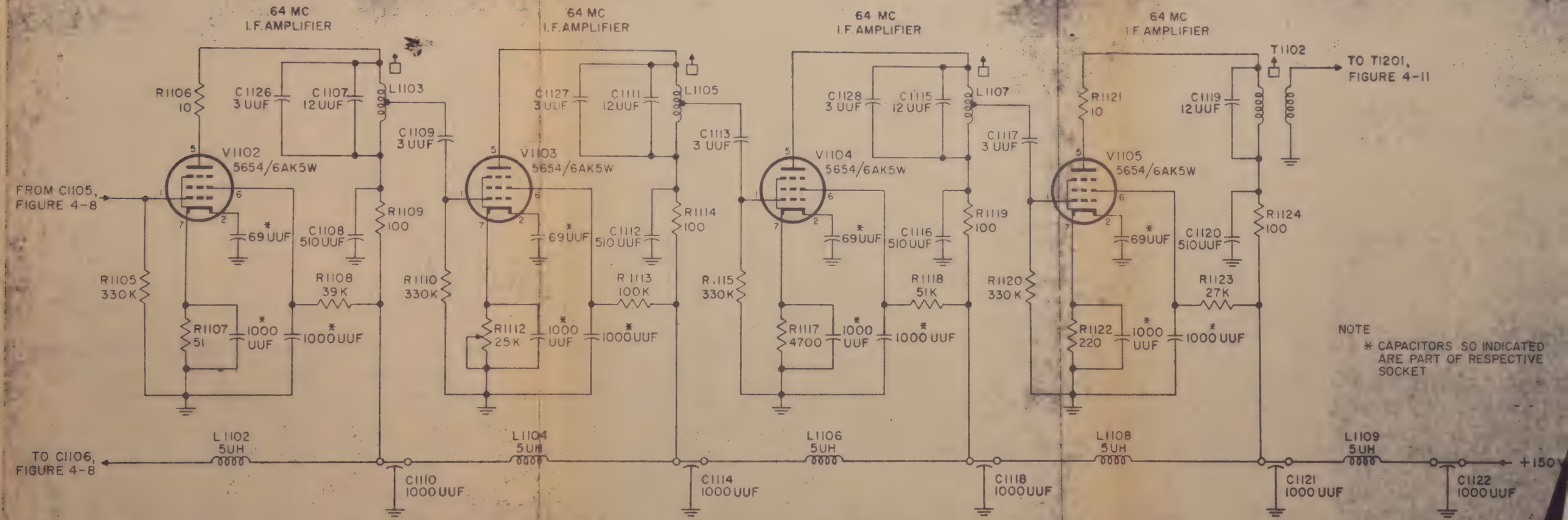


Figure 4-9. I-F Amplifier, 64-MC I-F Amplifier Simplified Schematic

4-47. 1-MC I-F AMPLIFIER.

4-48. The 1-mc i-f amplifier unit consists of four major functional segments: the 65-mc local oscillator V1201, mixer V1202, 1-mc amplifier V1203, and phase inverter V1204 and square law detector V1205, V1206. Shown in figure 4-10 is a simplified schematic of the 65-mc local oscillator. This segment consists of a crystal-controlled oscillator and a frequency doubler. The crystal Y1201 is used to generate a frequency of 32.5 megacycles. The V1201 tube is a dual triode (12AT7WA), the first half of which is utilized as a 32.5-mc oscillator and the second half of which is used as a frequency doubler. The oscillator used is of the plate-to-cathode feedback type, feedback taking place through capacitor C1204. The output of the oscillator is fed to the grid of frequency doubler V1201 through capacitor C1207. This stage operates under Class C conditions. A tuned circuit, consisting of capacitor C1206 and inductor L1205, is used in the plate circuit of the frequency doubler and is tuned to 65 megacycles. The 65-mc output signal is fed to the suppressor grid of mixer tube V1202.

4-49. Shown in figure 4-11 is a simplified schematic of the mixer V1202. This stage receives two input signals, one at a frequency of 65 megacycles and the other at a frequency of 64 megacycles. The resultant beat signal at the output of the mixer is one megacycle. The output of the mixer is then fed to the 1-mc amplifier. The 65-mc input signal to the mixer is derived from the output of the 65-mc local oscillator and is fed to the suppressor grid of tube V1202. The 64-mc input signal to the mixer is derived from the output of the 64-mc i-f amplifier and is fed to the control grid of tube V1202 through a step-up transformer T1201. This transformer is used for matching the impedance of the 50-ohm cable which feeds the 64-mc signal from the 64-mc i-f amplifier to the transformer T1201. This transformer is tuned to 64 megacycles and, in addition, feeds a voltage to the tapping point on the cathode resistor in order to provide proper bias to the tube for proper mixing. The plate circuit of this tube contains a tune circuit Z1201 tuned to one megacycle. The coil L1 of this tuned circuit is tapped in order to reduce the loading on the coil and increase the Q characteristic, thus giving better selectivity.

4-50. Shown in figure 4-12 is a simplified schematic of the 1-mc amplifier stage V1203. The 1-mc input signal to the amplifier is fed to the control grid of V1203. The amplified output signal appears in the tuned circuit Z1202, which is identical to the tuned circuit Z1201 in the mixer output stage, coil L1 in Z1202 also being tapped. The output signal of the

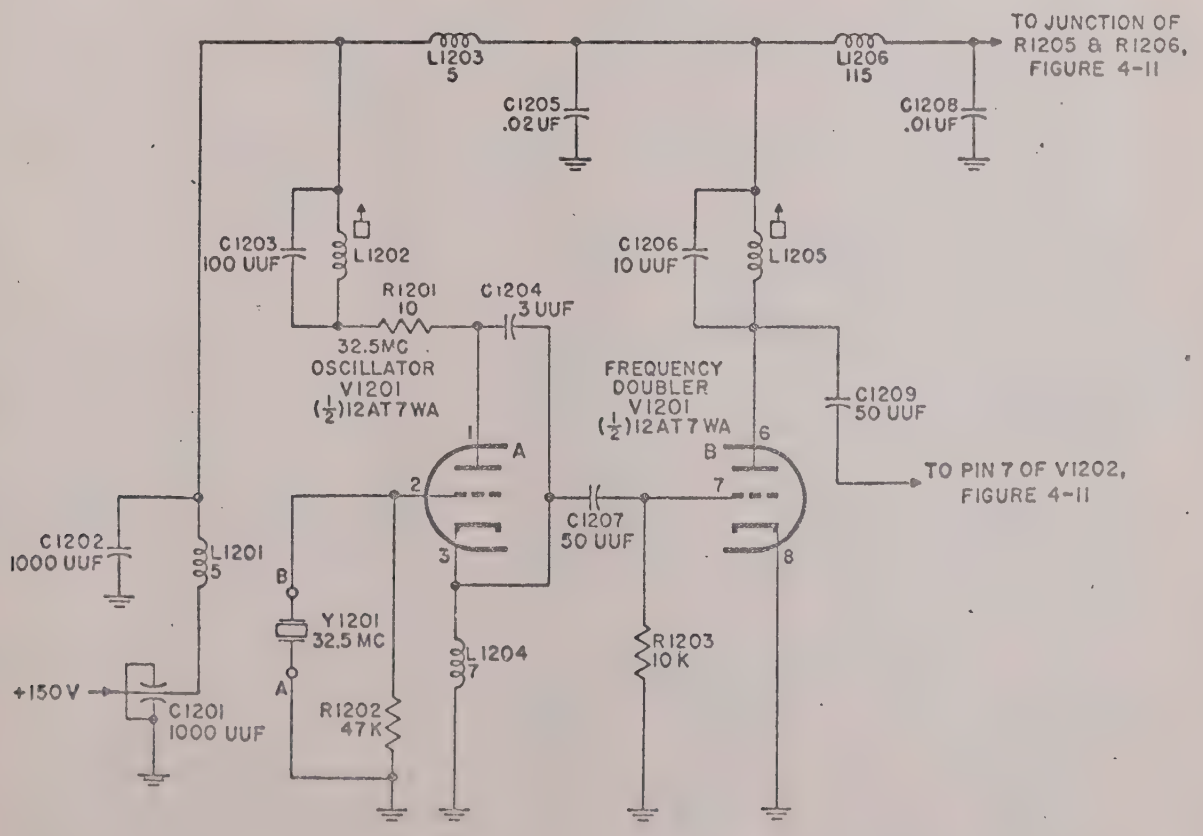


Figure 4-10. 65-MC Local Oscillator, 1-MC Amplifier, Simplified Schematic

amplifier is fed to a phase inverter through capacitor C1220.

4-51. Shown in figure 4-13 is a simplified schematic of the phase inverter stage V1204 and square law detector stage V1205. The output of the 1-mc amplifier stage V1203 is fed to the grid of the second half of phase inverter V1204. This inverter is of the cathode-coupled type. The input signal applied to the grid of the second half of the phase inverter is also fed to the grid of the first half of the inverter resistors R1219 and R1215. The phase inverter stage produces two output signals which are 180 degrees out of phase. Each output signal is fed to the control grid of a square law detector. One output signal is fed to detector V1205 through capacitor C1223, while the other output signal is fed to detector V1206 through capacitor C1224. The test point TP1201 is provided in the cathode circuit of the inverter to permit tuning and selectivity measurements of the 1-mc amplifier unit to be made without the introduction of distortion from the square law detector.

4-52. The two square law detectors constitute a push-pull squaring circuit. The grids are driven push-pull, while the plates are connected in push-push fashion. The result is that the odd-powered harmonics of the grid signal are cancelled out. In addition, the tubes permit the fourth power content of the fourth harmonic to be very low, leaving the d-c component and the square law component to remain. This circuit functions properly for pulse signals, but does not operate well over as wide a range for sine wave signals. However, all signals applied to the square law detectors are pulse signals due to the frequency-time domain conversion. The output of the last detector stage is fed to the video network in the power supply and video unit.

4-53. The 6AV6 type of tube used in the squaring circuit possesses a peculiar grid-voltage, plate-current characteristic which makes it especially suitable for this squaring circuit. The screen and grid bias voltages for both 6AV6 tubes provide efficient square law operation. Variable resistor R1229 is the detector

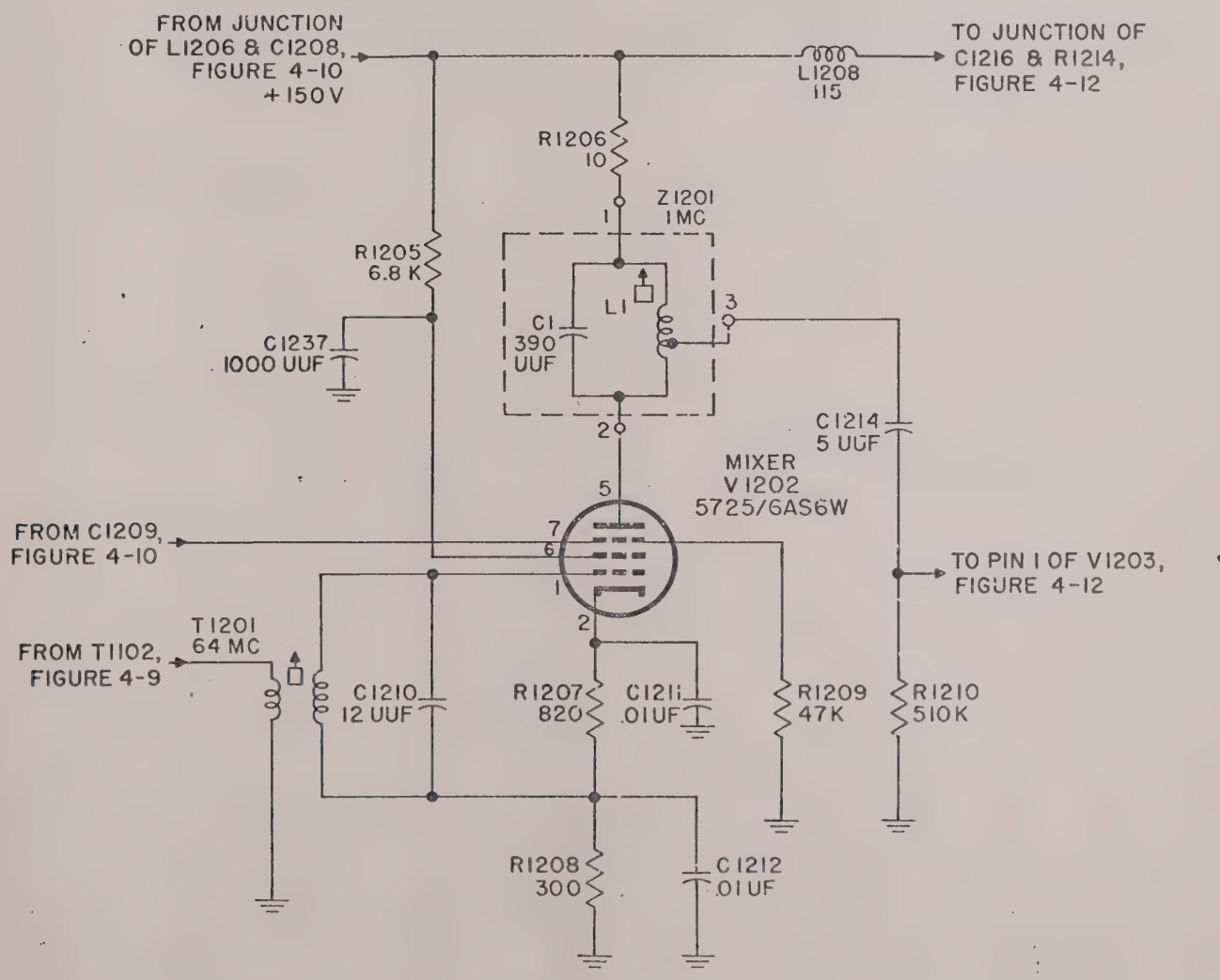


Figure 4-11. Mixer Stage V1202, 1-MC I-F Amplifier, Simplified Schematic

balancing potentiometer and is employed for matching one 6AV6 tube with the other. This is necessary because of the fine differences which exist between the 6AV6 tubes. Since the 6AV6 tube is a squaring amplifier, the signal in the plate circuit of the square law detector is two megacycles. This 2-mc signal, therefore, is much easier to filter. Capacitor C1226 performs the filtering action. The plate-load resistor R1225, which is 10,000 ohms, provides maximum square-law operation. The +150-volt and the -150-volt leads in the 1-mc i-f amplifier unit are well filtered to prevent interaction between this subassembly and other units.

4-54. SWEEP FREQUENCY GENERATOR.

4-55. The sweep frequency generator consists of four functional segments: The reactance modulated oscillator, two r-f amplifier stages, a frequency tripler and a frequency doubler. Shown in figure 4-14 is a simplified schematic of the reactance modulated oscillator. This segment consists of a reactance modulator stage V1501 and a frequency-modulated oscillator stage V1502. The reactance modulator is a pentode, type 6AK5, and the frequency modulated oscillater is a dual triode, type 12AT7, being cathode coupled. The basic center frequency of the reactance modulated oscillator is 37-1/3 megacycles.

4-56. The sawtooth signal from the sawtooth generator in the power supply and video unit is fed to the control grid of the modulator V1501 through resistor R1501. The -150-V d-c signal from the power supply unit is fed to the control grid of modulator V1501 through potentiometers R1017 and R1016A, and resistor R1502. Potentiometers R1016B, R1018, R1017 and R1016A, control the fine and coarse centering of the spectrum display. The output of the modulator is fed to the grid of the first half of the dual triode V1502. The plate output of this half of the triode is fed back to the control grid of the reactance modulator through capacitor C1505 and resistor R1503. The output of the modulator is also fed to the grid of the second half of the dual triode V1502 through resistors R1510 and R1511. The plate output of the second half of the triode is fed to inductor L1504 which is the frequency controlling element of the oscillator. The frequency of the oscillator varies when the reactance across inductor L1504 is changed by the action of the reactance modulator. Inductor L1504 is tuned to 43 megacycles to insure sufficient linearity to exist over the prescribed frequency range (32.8 to 41.9 mc) of the oscillator.

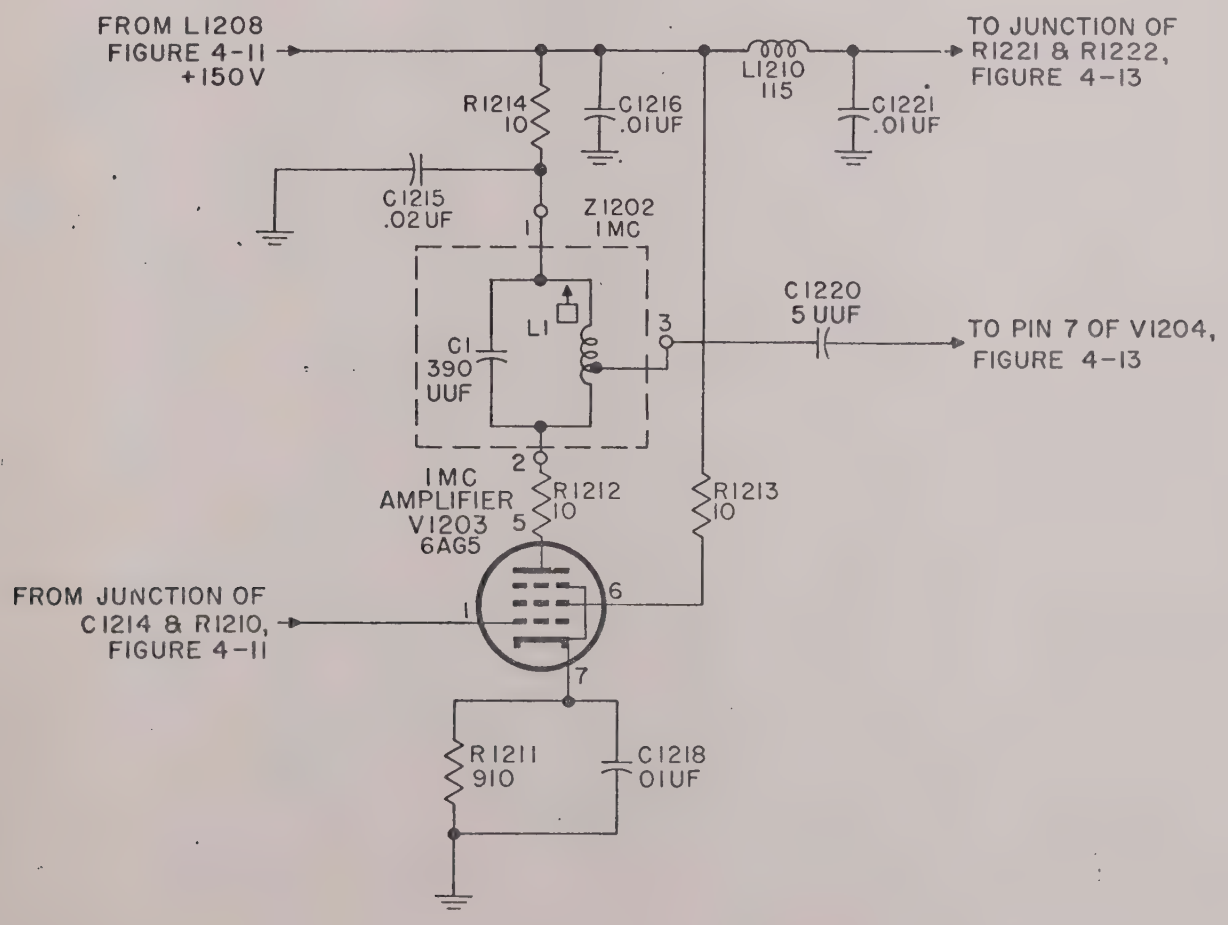


Figure 4-12. 1-MC Amplifier Stage V1203, 1-MC I-F Amplifier, Simplified Schematic

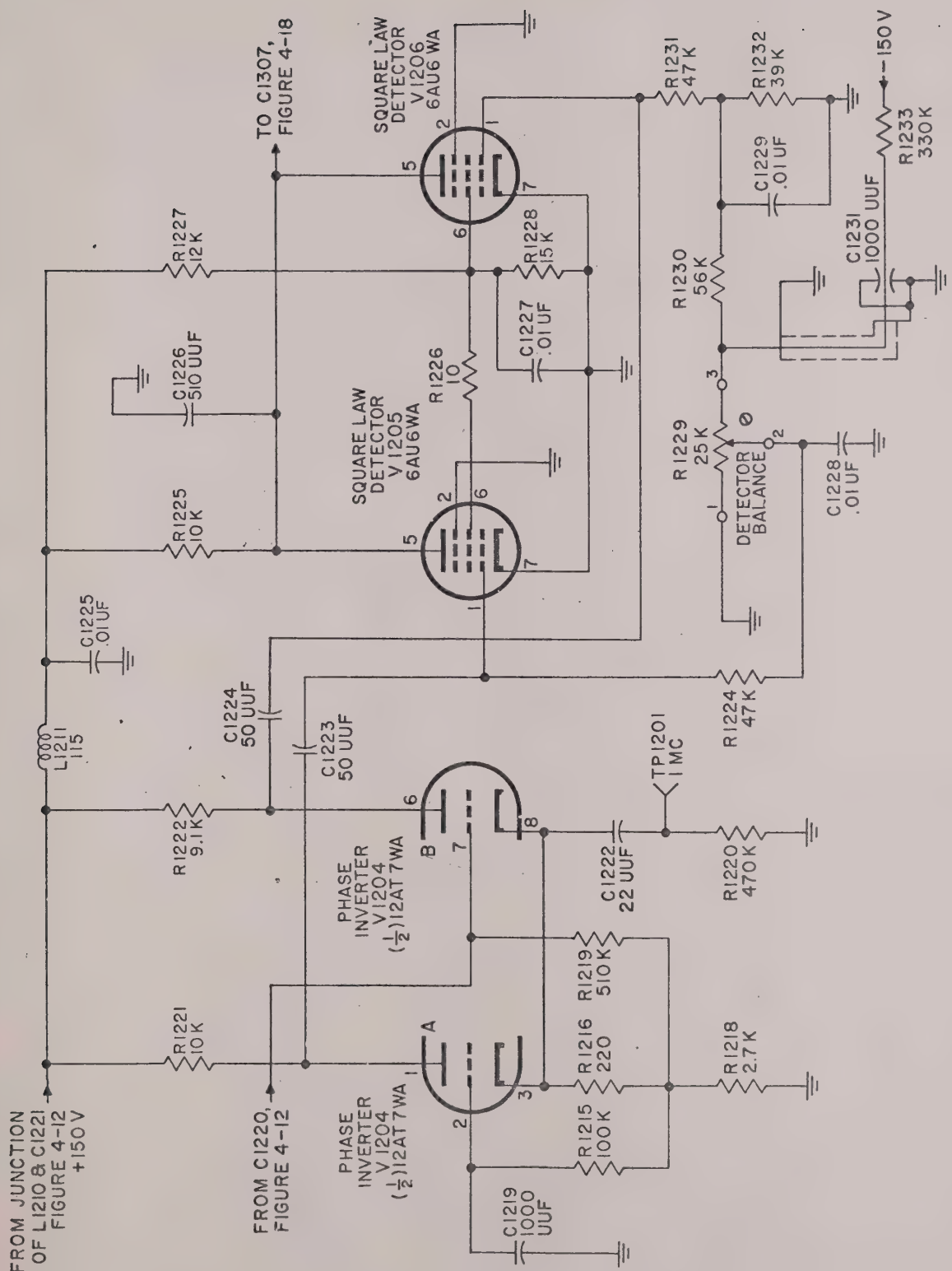


Figure 4-13. Phase Inverter V1204, and Square Law Detectors V1205, V1206, Simplified Diagram

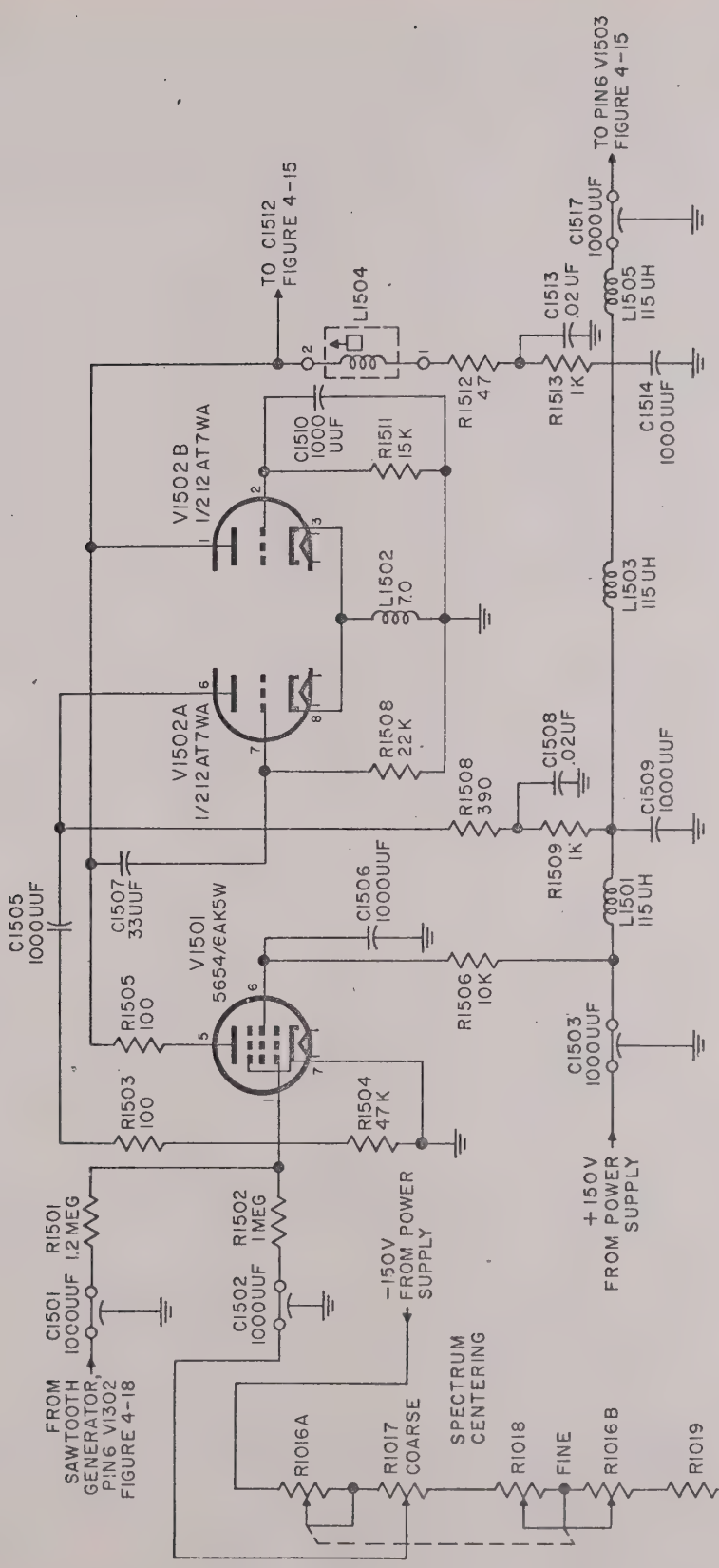


Figure 4-14. Reactance Modulated Oscillator, Sweep Frequency Generator, Simplified Schematic

The output signal of the oscillator is then fed to a two-stage r-f amplifier.

4-57. The mutual conductance of the reactance modulator V1501 is varied by changing the negative bias voltage applied to the control grid. The bias is obtained from the "SPECTRUM CENTERING" controls. The controls are part of a bleeder circuit starting from -150 volts dc down to ground. A comparatively large voltage is introduced at the input of the sweep frequency generator, the voltage being divided by a voltage divider network consisting of resistors R1502 and R1504. Resistor R1504 is a large divider (47,000 ohms) and is necessary in order to provide isclation between the centering control and the sawtooth signal input so that one signal will not load the other. The dynamic deviation of the oscillator is obtained by introducing the sawtooth signal to the control grid of modulator V1501. Capacitor C1502 is a 1000-uufd, feed-through capacitor used to prevent the r-f signal from feeding out of the cable to the power supply unit.

4-58. Shown in figure 4-15 is a simplified schematic of the r-f amplifier section of the sweep frequency generator. Two stages of r-f amplification are employed. The output of the reactance modulated oscillator is fed to the control grid of the first r-f amplifier V1503 through capacitor C1512. The output of the first r-f amplifier is fed to the control grid of the second r-f amplifier V1504 through capacitor C1516. The output of the second r-f amplifier is fed to a frequency tripler which triples the frequency of the reactance modulated oscillator. The type 6AH6 tubes used provide maximum gain. These tubes are of high mutual conductance. The plate resistors R1516 and R1519 are anti-parasitic resistors. Amplifier V1504 operates in a grid-current region, that is, much of the bias is obtained from the grid-leak network. The values of the cathode resistors R1515 and R1518 insure that the ratings of the type 6AH6 tubes will never be exceeded when a signal is absent.

4-59. Shown in figure 4-16 is a simplified schematic of the frequency tripler-doubler segment of the sweep frequency generator. The frequency tripler V1505 and the doubler V1506 utilizes a pentode type tube 6AK5. The amplified output of the r-f amplifier V1504 is fed to the control grid of the frequency tripler V1505. The tuned plate circuit Z1501 of V1505 is tuned to 112 megacycles. As a result, the signal from the reactance modulated oscillator is tripled and fed to the control grid of doubler V1506. The tuned plate circuit of V1506 is tuned to 224 megacycles. The frequency of the output signal of tripler V1505 is therefore doubled. The frequency-modulated output signal, centered about 224 megacycles, is then fed to mixer V1101 in the 64-mc i-f amplifier unit.

4-60. The frequency tripler V1505 operates under grid current conduction. Cathode resistor R1523 insures that the ratings of the tube will not be exceeded. The plate filter Z1501 is a double tuned network which is heavily loaded to give a large bandwidth. The frequency doubler V1506 also operates under grid current conduction, having only grid leak bias. This permits good sensitivity to result for the amount of

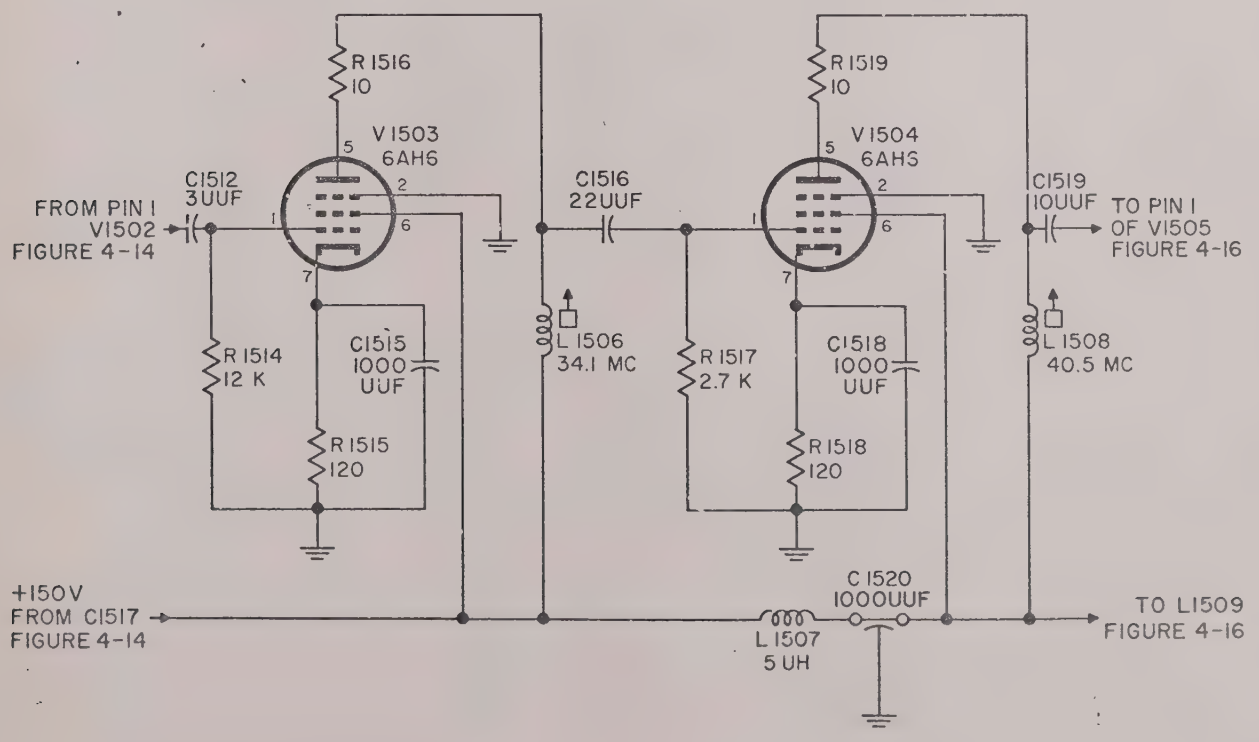


Figure 4-15. R-F Amplifier, Sweep Frequency Generator, Simplified Schematic

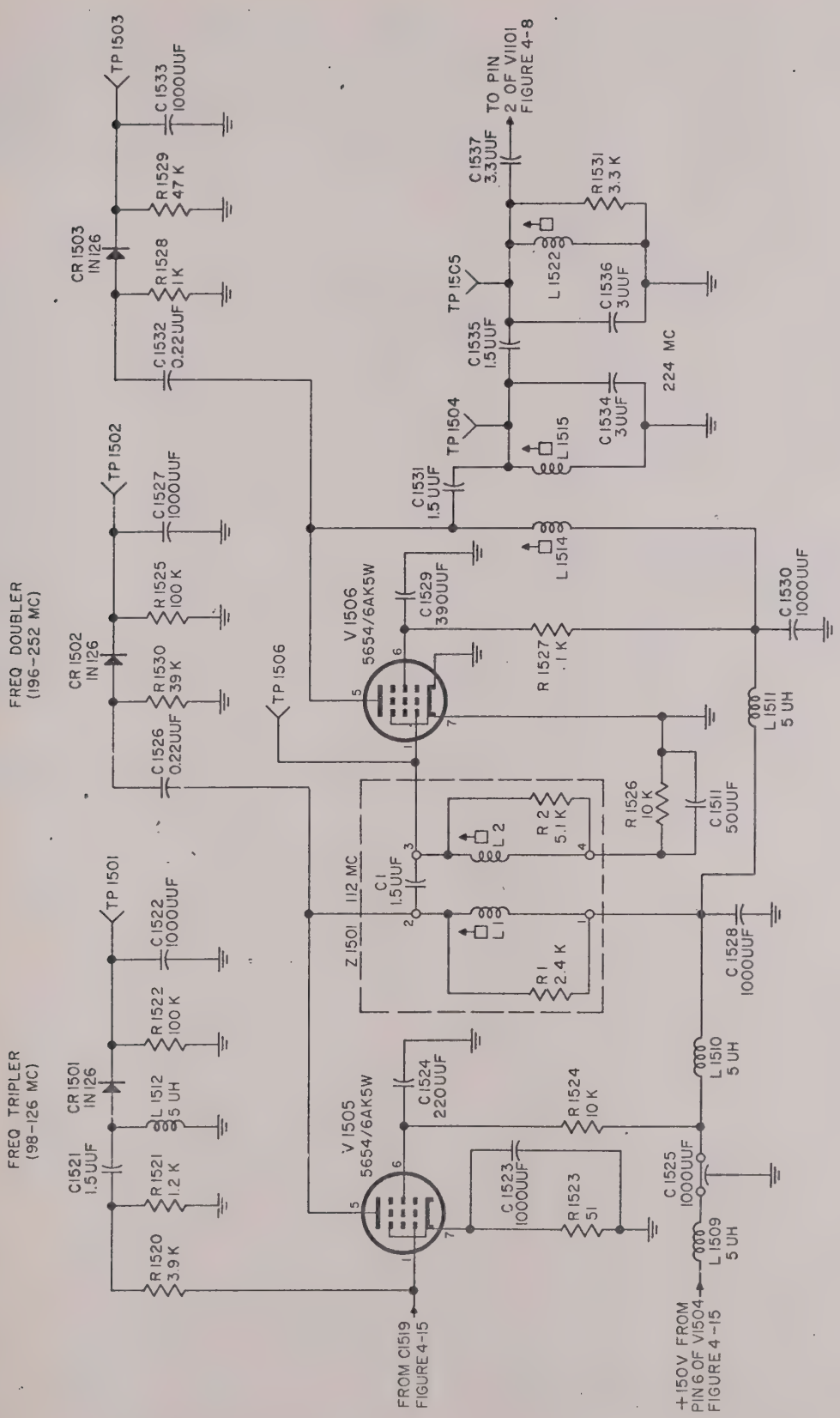


Figure 4-16. Frequency Tripler and Doubler, Simplified Schematic

output expected. The filter network in the output of of V1506 possesses a bandwidth of 55 megacycles. This filter network matches the comparatively high output impedance of the 6AK5 tube to a 50-ohm cable. The filter is also used to compensate for various voltage changes in the oscillators, amplifiers, and frequency multifliers along the line so that the output of the sweep frequency generator is reasonably flat.

4-61. POWER SUPPLY AND VIDEO

6-62. Shown in figure 4-17 is a simplified schematic of the power supply section of the power supply and video unit. When the "POWER" switch S1004 on the panel of the indicator drawer is on, the primary of transformer T1301 is excited with 115 volts ac. Transformer T1301 possesses three secondary windings which generate 190 volts, 160 volts, and 6.3 volts. The two selenium rectifiers CR1301 and CR1302 rectify the two 190-volt and 160-volt signals. The 150 volts dc produced at the output of the power supply is series regulated and amplified by amplifier V1312. Resistor R1361 is the +150-volts ADJUST control which is accessible on top of the power supply and video chassis. The +150-volt d-c signal is the plate voltage supplied to the 1-mc amplifier, the 64-mc amplifier, the spectrum calibrator, and the sweep frequency generator. The -150 volts dc produced at the output is regulated by regulator V1310. Resistor R1352 is the -150-volt ADJUST control which is accessible on top of the power supply and video chassis.

4-63. Shown in figure 4-18 is a simplified schematic of the video section of the power supply and video unit. The sawtooth generating circuits shown perform a dual purpose. The network modulates the sweep frequency generator signal of 224 megacycles in the sweep frequency generator and deflects the cathode-ray beam. The multivibrator V1301 generates square wave pluses which are fed to the input of sweep generator V1302. The sawtooth output of the sweep generator is fed into sweep amplifier V1302 for signal amplification before being fed to the sweep frequency generator where the sawtooth voltage frequency modulates the 224-mc signal. A portion of the input to V1302 is fed to the grid of the first half of sweep amplifier V1303 through horizontal gain control R1317. The output of sweep amplifier V1303 is fed to the horizontal deflection plates of the cathode-ray tube. The video output from the 1-mc i-f amplifier unit is impressed upon the grid of the first half of video amplifier V1304. After video amplification, the output signal from V1304 is d-c restored by V1307, the grid and plate of which are tied together to form a diode. The restored signal is further amplified by V1305 before being fed to the vertical plates of the cathode-ray tube.

4-64. Note that a portion of the output of the first half of video amplifier V1305 is fed to the control grid of the intensifier squaring tube V1306. The output of V1306 is amplified by V1307, the intensifier amplifier. The output of V1307, adjustable by intensifier control R1341, is then fed to the focus electrode of the cathode-ray tube, the intensifier network is incorporated to permit brightening of the trace on the scope screen so that the short transient of the r-f pulse presented can be clearly viewed. To intensify the trace and, at the same time, preserve optimum focus, the out-of-phase signal from V1307 is simultaneously applied to the focus electrode.

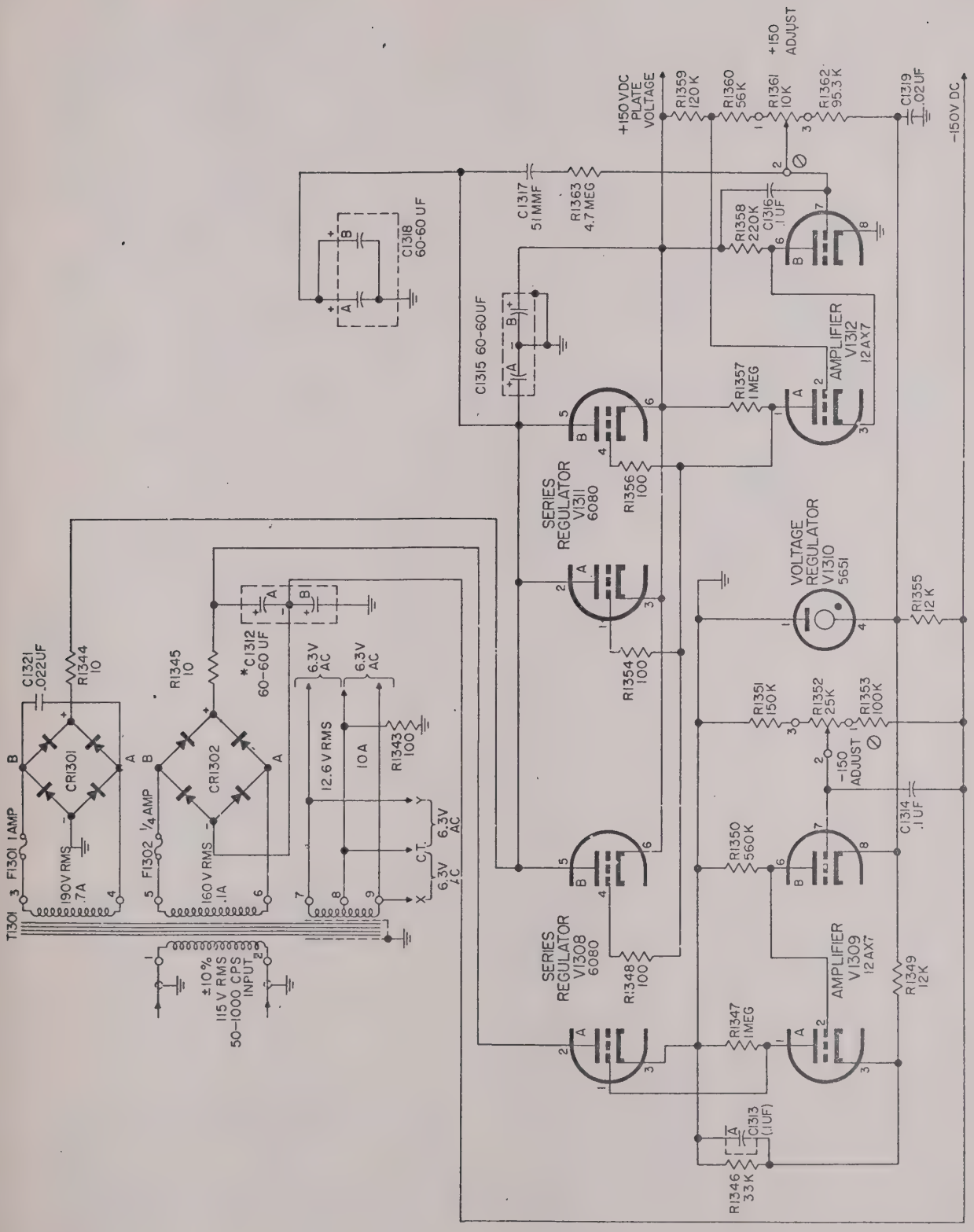


Figure 4-17. Power Supply, Simplied Schematic

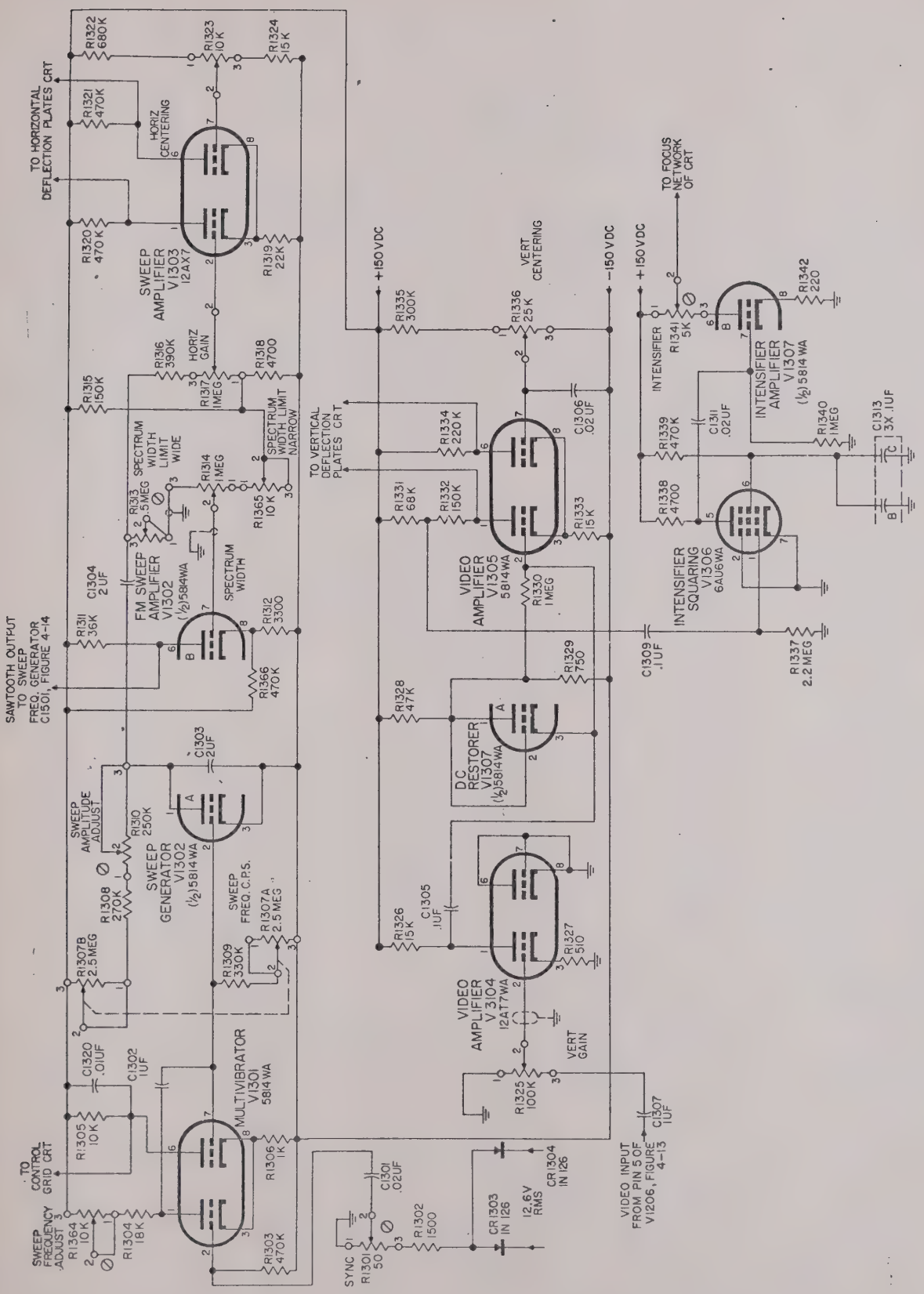


Figure 4-18. Video Section, Simplified Schematic

SECTION V

ROUTINE MAINTENANCE

5-1. PLATE VOLTAGE SUPPLY. Check and adjust the plate voltage supply in the indicator unit (figure 5-1) using the following procedure:

a. Connect the power cord into a power supply of 115 volts, 50 to 1000 cps ac.
b. Place the "POWER" switch (12, figure 5-1) on. The power indicator lamp (13, figure 5-1) must light.
c. Rotate the "METER SELECTOR" switch (22, figure 5-1) to the "LINE VOLTS" position. The voltage reading on the voltmeter (23, figure 5-1) must be approximately 115 volts.
d. Rotate the "METER SELECTOR" switch (22, figure 5-1) to the "+150 V" position. The voltage reading on the voltmeter (23, figure 5-1) must be 150 volts plus or minus 1 volt. If the reading does not fall within tolerance, follow the instructions given in steps f and g of this paragraph for an additional check and the necessary adjustments to be made.
e. Rotate the "METER SELECTOR" switch (22, figure 5-1) to the "-150 V" position. The voltage reading on the voltmeter (23, figure 5-1) must be 150 volts plus or minus 1 volt. If the reading does not fall within tolerance, follow the instructions given in steps f and g of this paragraph for an additional check and the necessary adjustments to be made.
f. Loosen the 15 panel screws (31, figure 5-1) on the indicator unit and slide the drawer forward. Re-

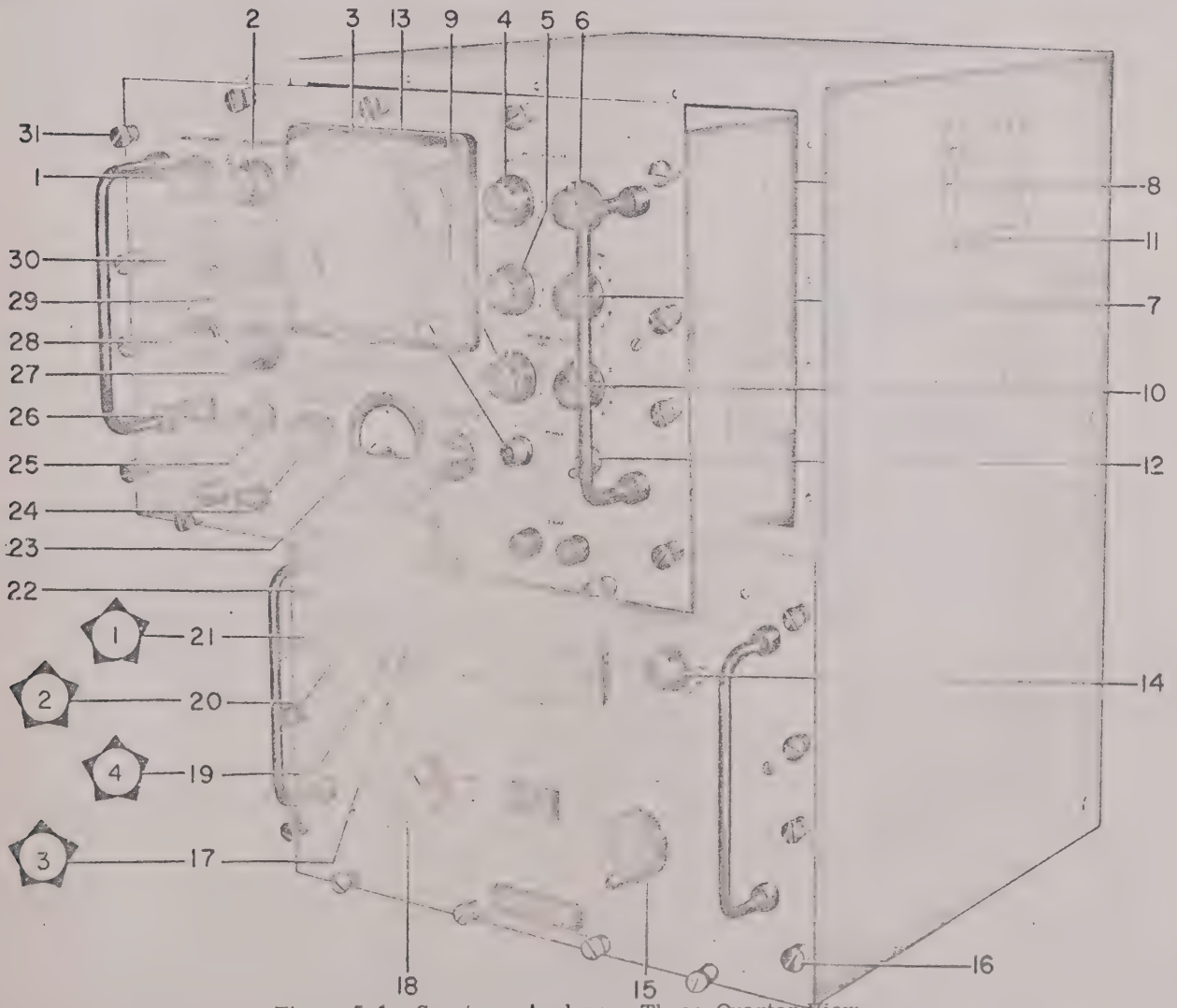


Figure 5-1. Spectrum Analyzer, Three-Quarter View

move the top cover of the drawer to gain access to the top of the power supply chassis (figure 5-2). Place the positive test lead of a suitable voltmeter into the +150-volt jack, test point 5 (figure 5-2) colored red, on top of the power supply chassis. Place the negative test lead of the voltmeter to chassis ground. Observe the voltmeter reading If the reading varies considerably from 150 volts, poteniometer R1361 (figure 5-2) requires adjustment as given in step g of this paragraph. Place the negative test lead of the voltmeter into the -150-volt jack, test point 6 (figure 5-2) colored white, and the positive test lead to chassis ground. Observe the voltmeter reading. If the reading varies considerably from 150 volts, potentiometer R1352 (figure 5-2) requires adjustment as given in step g of this paragraph.

g. Remove the voltmeter from the test jacks. Place the "METER SELECTOR" switch (22, figure 5-1) in the "+150 V" position and adjust R1361 (figure 5-2) until the voltmeter (23, figure 5-1) on the indicator unit panel reads 150 volts. Place the "METER SELECTOR" switch (22, figure 5-1) in the "-150 V" position and adjust R1352 (figure 5-2) until the voltmeter (23, figure 5-1) reads 150 volts.

h. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

5-2. SPECTRUM CENTERING. If the spectra received on the scope screen cannot be properly centered by using the "SPECTRUM CENTERING" controls (9, 10, figure 5-1), perform the following procedure to correct:

a. Loosen the 15 panel screws (31, figure 5-1), and slide the indicator drawer forward.

b. Set the "SPECTRUM CENTERING" "COARSE" and "FINE" controls (9, 10, figure 5-1) to their zero positions. Adjust potentiometer R1016 (11, figure 5-1) until the centering is restored on the scope screen. Allow setting to remain.

c. Carefully slide the drawer into the instrument case and secure all indicator panel screws.

5-3. SPECTRUM WIDTH. If the full 25-mc sweep cannot be obtained by using the "SPECTRUM WIDTH" control (27, figure 5-1), perform the following procedure to restore the full range:

a. Loosen the 15 panel screws (31, figure 5-1) and slide the indicator drawer forward. Remove the top cover of the drawer to gain access to the power supply chassis (figure 5-2).

b. Set the "SPECTRUM WIDTH" control (27, figure 5-1) to "25" and adjust the potentiometer R1313 (figure 5-2) until the full range of the 25-mc sweep is restored on the scope screen.

c. Replace and secure the top cover of the indicator drawer. Slide the drawer into the instrument case and tighten all panel screws.

LEGEND FOR FIGURE 5-1

1. "HORIZ CENTERING" knob
2. "VERT CENTERING" knob
3. Scope Screen
4. "SPECTRUM CALIBRATOR" - "AMPLITUDE" knob
5. "FOCUS" knob
6. "SPECTRUM CALIBRATOR" - "FREQUENCY" knob
7. "BRIGHTNESS" knob
8. C1404
9. "SPECTRUM CENTERING" - "COARSE" knob
10. "SPECTRUM CENTERING" - "FINE" knob
11. R1016
12. "POWER" switch
13. "POWER" indicator lamp
14. "IF ATTENUATION - DB"
15. "TUNE" control
16. R-F tuner unit panel screw
17. "350-1000"
18. "BAND SELECTOR" switch
19. "1000-16000"
20. "150-350"
21. "10-150"
22. "METER SELECTOR" switch
23. Voltmeter indicator
24. "SCALE ILLUMINATION" knob
25. "INTENSIFIER" knob
26. "SYNC" control
27. "SPECTRUM WIDTH" knob
28. "SWEEP FREQUENCY" knob
29. "VERT GAIN" knob
30. "HORIZ GAIN" knob
31. Indicator unit panel screw

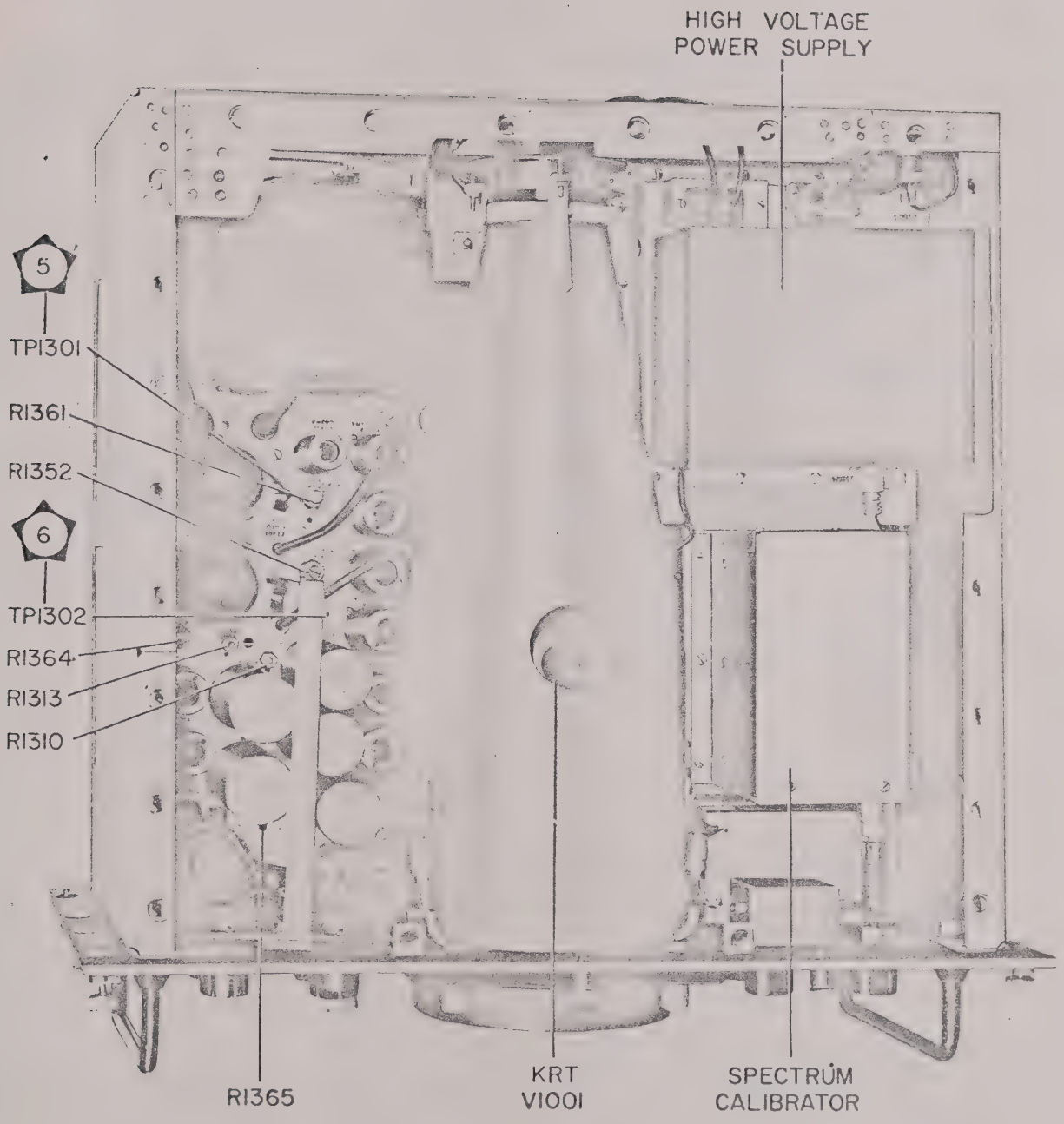


Figure 5-2. Pulse Analyzer Indicator, Top View

SECTION VI

FIELD MAINTENANCE

6-1. PRELIMINARY PROCEDURE.
a. Connect the analyzer power cord to the Variac and the AN/SPM-3 voltmeter.
b. Connect the Variac to an external supply of 115 volts, 50 to 1000 cps, ac.
c. Adjust the Variac to indicate 115 volts on the AN/SPM-3.

6-2. HIGH VOLTAGE POWER SUPPLY.
a. Using a Simpson Model 260 (250 volt scale), check the d-c voltage at test points 7 and 8 (figure 6-1). Multiply the meter reading by nine. The acceptable values are listed in table IX.
b. Using a Ballantine Model 300, check the ripple voltage present at test point 7 and test point 8. The acceptable values are given in table IX.

6-3. POWER SUPPLY.
a. Using a Simpson Model 260, check the d-c voltage present at test points 5 and 6 (figure 5-2). The acceptable values are given in table IX. If the indication is abnormal, adjust R1361 (figure 5-2) for test point 5, and R1352 (figure 5-2) for test point 6.
b. Using a Ballantine Model 300, check the ripple voltage at test point 5 and test point 6. The acceptable values are given in table IX.

TABLE IX. VOLTAGE CHECKS

TEST POINT	VOLTAGE AND TOLERANCE	RIPPLE TOLERANCE
⑦ TP1601	+1500 ±100 volts	Less than 1.5 volts
⑧ TP1602	-1500 ±100 volts	Less than 1.5 volts
⑤ TP1301	+150 ±1 volt	Less than 20 uv
⑥ TP1302	-150 ±1 volt	Less than 20 uv

6-4. LINEARITY.
a. Connect a Hewlett Packard Model 608 to test point A (figure 6-1). Set the Model 608 output to 64 mc at 1000-cps, 30% modulation.
b. Adjust R1310 (figure 5-2) for an evenly spaced pattern on the scope screen.
c. Adjust R1001 (figure 6-1) and vary the "FOCUS" control for a clear-sharp signal across the spectrum.

6-5. NOISE LEVEL.
a. Adjust peaking coil T1201 (figure 6-1) for maximum amplitude of nose.
b. Set the "VERT GAIN" knob (29, figure 5-1) at maximum, fully clockwise.
c. Adjust R1112 (figure 6-1) for approximately 1/4-cm average of noise.
d. Set the "VERT GAIN" knob between "3" and "4". The noise level should be barely perceptible.

6-6. SWEEP FREQUENCY.
a. Set the "SWEEP FREQ" knob (28, figure 5-1) to "30".
b. Disconnect cable plug P1303 (figure 6-1) from test point B (J1202) and connect plug P1303 to the output of a Hewlett Packard Model 200c to 30 cps.
c. Adjust the "SWEEP FREQ" knob (28, figure 5-1) to obtain a single sine-wave indication on the scope screen. If this cannot be obtained, adjust R1364 (figure 5-2) and the "SWEEP FREQ" knob, respectively, until a single sine-wave indication is observed.
d. Loosen the "SWEEP FREQ" knob and set the knob to read "30"; tighten knob.
e. Check the "SWEEP FREQ" knob at "25" and "20", varying the Model 200c output accordingly. Refer to step c to calibrate the "SWEEP FREQ" dial at these positions.

6-7. VIDEO AMPLIFIER.
a. Connect a Ballantine Model 300 to the Hewlett Packard Model 200c output.
b. Connect the Model 200c to P1303 (same as step 6-6b).
c. Set the Model 300 on the 1-volt scale and the gain on the model 200c to 16 on the db scale.
d. Set the "INTENSIFIER" (25, figure 5-1) fully counterclockwise; "VERT GAIN" knob (29, figure 5-1) to obtain 5-cm deflection of signal.

NOTE

Do not change this setting throughout the test procedure.

e. Vary the Model 200c gain control to obtain a 5-cm deflection of signal on the scope screen for each of the following frequencies: 20 cps, 60 cps, 100 cps, 300 cps, 500 cps, 700 cps, 1 kc, 3 kc, 5 kc, and 8 kc. The reading on the Model 300 must be flat within 2 db.

6-8. SPECTRUM CALIBRATOR.
a. Connect an LA-6 at 160 mc to test point 1 (21. figure 5-1).
b. Set the "AMPLITUDE" knob (4, figure 5-1) of the "SPECTRUM CALIBRATOR" to obtain 3-cm deflection of signal on the scope screen.
c. Zero-beat the "SPECTRUM CALIBRATOR" against the 160-mc input by varying the "FREQUENCY" knob (6, figure 5-1).
d. Loosen the "FREQUENCY" knob and set it to "0". If this adjustment does not permit full range of the control, adjust the shaft.
e. Set the "SPECTRUM WIDTH" knob at minimum width.
f. Adjust R1016 (11, figure 5-1) to bring the indication in the center.
g. Zero-beat the signal from the FR-6 against the

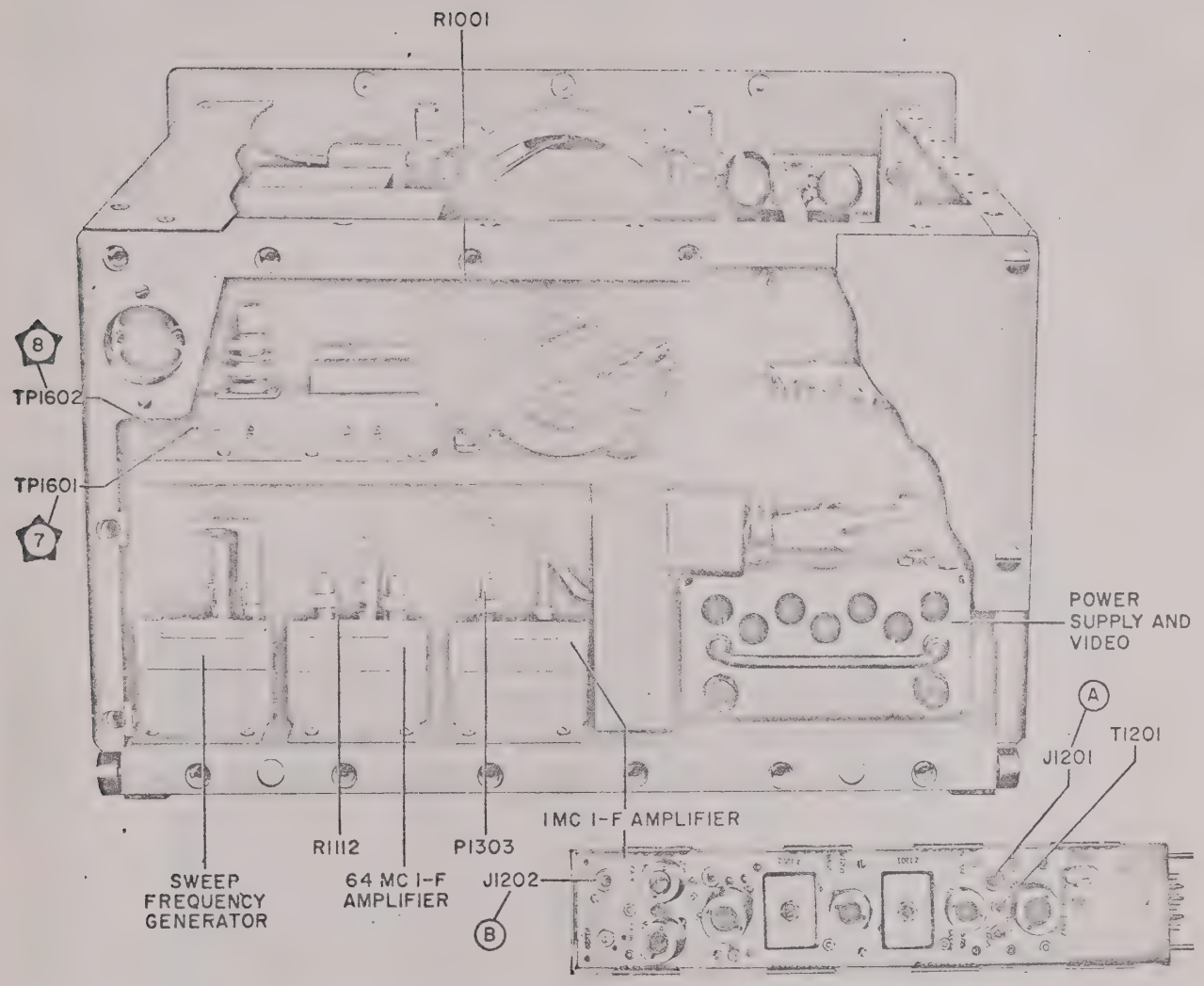


Figure 6-1. Pulse Analyze Indicator, Rear View

calibrator signal for the following frequencies by varying the "FREQUENCY" knob (6, figure 5-5) above and below the 160-mc ("O") setting: 145 mc, 150 mc, 155 mc, 160 mc, 165 mc, 170 mc, and 175 mc. The calibrator frequency must be with ±0.5 mc.

6-9. SPECTRUM WIDTH.

a. Connect an LA-6 to test point 1 (6, figure 5-1).

b. Set the "FREQUENCY" knob (6, figure 5-1) to "O" (160 mc); "AMPLITUDE" knob (4, figure 5-1) to obtain 3-cm deflection of signal on the scope screen; "SPECTRUM WIDTH" knob (27, figure 5-1) at minimum width.

NOTE

Use this signal as a marker. Keep the signal on zero by varying the "SPECTRUM CENTERING" knob (10, figure 5-1).

c. Vary the signal from the LA-6 to one end of the trace (5-cm mark) and then to the other end of the trace (5-cm mark), recording the frequency reading at each end. Subtract the lower reading from the higher reading to obtain the bandwidth reading.

d. Repeat step c for all "SPECTRUM WIDTH" dial settings (1, 2, 3, 4, 5, 6, 10, 15, 20, and 25). The full range of the "SPECTRUM WIDTH" knob must not be less than 450 kc, nor more than 28 mc.

e. Adjust R1365 (figure 5-2) to calibrate the low end of the dial, and R1313 (figure 5-2) to calibrate the high end of the dial. If necessary, the "SPECTRUM WIDTH" knob may be reset.

6-10. 160-MEGACYCLE I-F ATTENUATOR.

a. Connect a Hewlett Packard Model 608 signal generator to test point 1 (21, figure 5-1).

b. Set the "BAND SELECTOR" switch (18, figure 5-1) to the "10-150 MCS WIDE" position; "IF ATTENUATION - DB" switch (14, figure 5-1) to "O".

c. Set the signal generator to 160 mc, cw. Set the attenuator control of the signal generator to obtain 5-cm deflection of signal on the scope screen.

d. Record the attenuator reading of the signal generator in db.

e. Set the "IF ATTENUATION - DB" switch to "54".
f. Set the attenuator control of the signal generator 54 db above step d.
g. Adjust R2022 (figure 6-2) to obtain 5-cm deflection of signal.
h. Set the "IF ATTENUATION - DB" switch to "36".
i. Set the attenuator control of the signal generator 36 db above step d.
j. Adjust R2014 (figure 6-2) to obtain 5-cm deflection of signal.
k. Set the "IF ATTENUATION - DB" switch to "24".
l. Set the attenuator control of the signal generator 24 db above step d.
m. Adjust R2001 (figure 6-2) to obtain 5-cm deflection of signal.
n. Set the "BAND SELECTOR" switch (18, figure 5-1) to the "10-150 NARROW" position; "IF ATTENUATION - DB" switch (14, figure 5-1) to "0".
o. Set the attenuator control of the signal generator to obtain 5-cm deflection of signal on the scope screen.
p. Record the attenuator reading of the signal generator in db.
q. Set the "IF ATTENUATION - DB" switch to "54".
r. Set the attenuator control of the signal generator 54 db above step p.
s. Adjust R2023 (figure 6-2) to obtain 5-cm deflection of signal.
t. Set the "IF ATTENUATION - DB" switch to "36".
u. Set the attenuator control of the signal generator 36 db above step p.
v. Adjust R2015 (figure 6-2) to obtain 5-cm deflection of signal.
w. Set the "IF ATTENUATION - DB" switch to "24".
x. Set the attenuator control of the signal generator 24 db above step p.
y. Adjust R2004 (figure 6-2) to obtain 5-cm deflection of signal.
z. Check "IF ATTENUATION - DB" switch in the "6," "12," "18," "30," "42," "48," and "60" positions with "BAND SELECTOR" switch in the "10-150 WIDE" and the "10-150 NARROW" positions, successively. The readings must be within ±1 db.

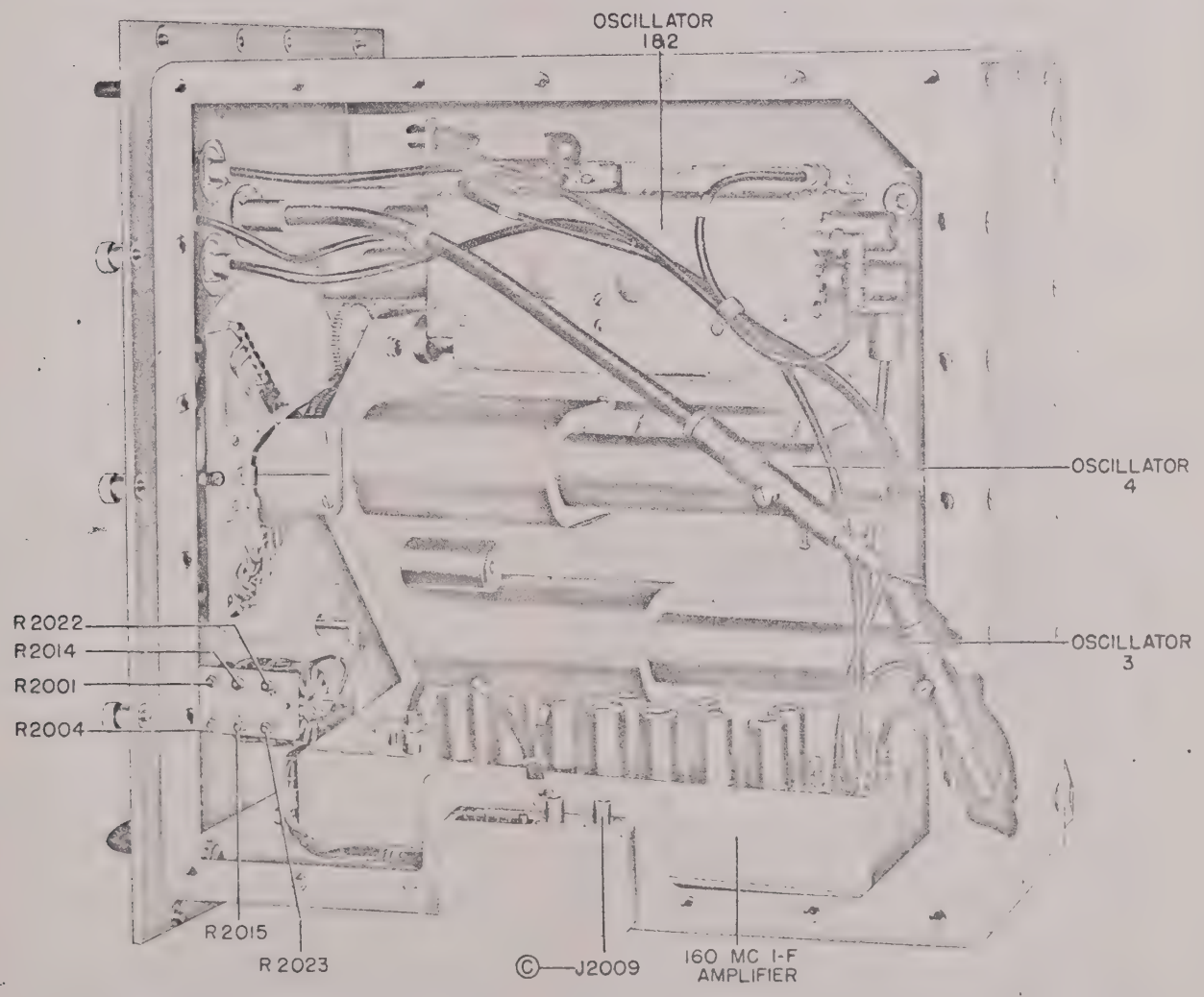


Figure 6-2. R-F Tuner, Top View

6-11. AMPLITUDE COMPARATOR.

NOTE

The following procedure is also used as a response check for 160-mc i-f.

a. Set the "FREQUENCY" knob (6, figure 5-1) to "0" (160 mc).
b. Set the "VERT GAIN" knob (29, figure 5-1) to "2". Set the "AMPLITUDE" knob (4, figure 5-1)to obtain between 3- and 4-cm deflection of signal (record this reading).

NOTE

Do not change the settings in step b throughout the procedures given in this paragraph.

c. Disconnect the calibrator cable from test point C (figure 6-2). Connect a Hewlett Packard Model 608 signal generator to test point C (J2009).
d. Set the signal generator to 160 mc and adjust the attenuator of the signal generator to obtain the same deflection in cm as that obtained with the spectrum calibrator input.
e. Record the attenuator reading of the signal generator in db as the input level for this frequency.
f. Disconnect the signal generator from test point C.
g. Set the "FREQUENCY" knob (6, figure 5-1) and the signal generator in step d to 147.5 mc, 150 mc, 155 mc, 160 mc, 165 mc, 170 mc, and 172.5 mc, respectively. Record the input level at each point by repeating steps c through f.
h. Use an insulated screw driver and adjust C1404 (8, figure 5-1) to obtain a flat signal, within 2 db, from the spectrum calibrator from 147.5 to 172.5.

6-12. SWEEP FREQUENCY LINEARITY.
a. Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "25"; "AMPLITUDE" knob (4, figure 5-1) to "OFF"; "VERT GAIN" knob (29, figure 5-1) between "3" and "4".
b. Connect two FR-6 frequency meters in parallel to test point 1 (21, figure 5-1).
c. Set one LA-6 to 160 megacycles. Use this signal to monitor the center frequency (160 mc) to eliminate drift that might occur during the test.
d. Set the second LA-6 to 147.5 mc so that a marker appears at the margin of the screen. Shift the frequency of the LA-6 in 2.5-mc steps to 172.5 mc. Markers 2.5 mc apart should appear evenly spaced at each cm across the trace.

6-13. VIDEO DETECTOR.
a. Set the "VERT GAIN" knob (29, figure 5-1) to "10".
b. Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "1".
c. Connect a Hewlett Packard Model 608 to test point 1 (21, figure 5-1). Set the signal generator to 160 mc, cw.
d. Record the attenuator reading of the signal generator at each check point (1-cm, 2-cm, 3-cm, 4-cm, and 5-cm deflection of signal) on the scope screen.
e. The reading for 1-cm deflection of signal may be any value. The reading for 4-cm deflection of signal must be twice the amount ±0.15 microvolts than that obtained with 1-cm deflection of signal.
f. Repeat steps b through e for the following settings of the "VERT GAIN" knob (29, figure 5-1), "6" and "2".

6-14. HORIZONTAL AMPLIFIER LINEARITY.
a. Disconnect cable plug P1303 from test point B (figure 6-1).
b. Connect cable plug P1303 to the output jack of pulse generator LA-592D.
c. Set the "SWEEP FREQ" knob (28, figure 5-1) to "30"; "VERT GAIN" knob (29, figure 5-1) between "3" and "4"; "SPECTRUM WIDTH" knob (27, figure 5-1) to "25".
d. Set the oscillator frequency dial on the pulse generator to 330 cps; coarse attenuator to 20-200 output; selector to negative narrow; sync selector to 200-2000-cps range.
e. Check the trace on the scope screen. A pulse must appear at each cm ±0.5 cm.

6-15. TUNER CALIBRATION. Check the tuner calibration by zero-beating frequency meter LA-6 (100-500 mc) or frequency meter LA-61 (500-2100 mc) against the spectrum analyzer for the appropriate settings of the "BAND SELECTOR" switch and "TUNE" control listed in table X. The tuning dial readings of the spectrum analyzer must be within one percent of the LA-6 or LA-61 frequency.

NOTE

The LA-61 may be used below 500 mc by using harmonics. Oscillators 1, 2, and 3 oscillate 160 mc above the frequency being checked. Oscillator 4 oscillates 160 mc below the frequency being checked.

6-16. OVERALL SENSITIVITY. Check the spectrum analyzer overall sensitivity by following the steps given in table XI through table XIV. The signal-to-noise ratio must be 2- to 1-cm deflection of signal on the scope screen for all the overall sensitivity checks.

6-17. SPURIOUS RESPONSES.
a. With no signal input, rotate the "TUNE" control (15, figure 5-1) throughout the dial range for all positions of the "BAND SELECTOR" switch ("10-150 MCS NARROW," "10-150 MCS WIDE," "150-350 MCS," "350-1000 MCS," "1-2 KMCS," "2-4 KMCS," "4-8 KMCS," and "8-16 KMCS").
b. Any spurious response, throughout step a, must not be more than twice the amount of the noise level.

6-18. TROUBLE ANALYSIS.

6-19. Table XV is an aid in locating troubles that might occur in the spectrum analyzer. It lists troubles, probable causes, and the remedies to be performed by field maintenance personnel.

6-20. REMOVAL AND REPLACEMENT. Replace defective parts with the same type replacement parts. After replacing any electronic parts in any subassembly, the associated circuit should be checked for its minimum performance standard, as listed in para-

TABLE X. TUNER CALIBRATION

STEP	TEST POINT*	FR-6 SETTING	FR-61 SETTING	"BAND SELECTOR" SWITCH	"TUNE" CONTROL
1	(1) (21, fig. 5-1)	170 mc		"10-150 MCS WIDE"	"10"
2	Same as step 1	200 mc		Same as step 1	"40"
3	Same as step 1	240 mc		Same as step 1	"80"
4	Same as step 1	280 mc		Same as step 1	"120"
5	Same as step 1	320 mc		Same as step 1	"160"
6	(2) (20, fig. 5-1)	300 mc		"150-350 MCS"	"140"
7	Same as step 6	360 mc		Same as step 6	"200"
8	Same as step 6	410 mc		Same as step 6	"250"
9	Same as step 6	460 mc		Same as step 6	"300"
10	Same as step 6		510 mc	Same as step 6	"350"
11	(3) (17, fig. 5-1)		510 mc	"350-1000 MCS"	"350"
12	Same as step 11		660 mc	Same as step 11	"500"
13	Same as step 11		710 mc	Same as step 11	"650"
14	Same as step 11		860 mc	Same as step 11	"700"
15	Same as step 11		1160 mc	Same as step 11	"1000"
16	(4) (19, fig. 5-1)		790 mc	"1-2 KMCS"	"950"
17	Same as step 16		1040 mc	Same as step 16	"1200"
18	Same as step 16		1340 mc	Same as step 16	"1500"
19	Same as step 16		1640 mc	Same as step 16	"1800"
20	Same as step 16		1940 mc	Same as step 16	"2100"

* Connect the frequency meter to the test point.

TABLE XI. SENSITIVITY CHECK FOR BAND 10-150 MEGACYCLES*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(1) (21, fig. 5-1)	10 mc	"10"	Less than 150 uv.
2	Same as step 1	40 mc	"40"	Same as step 1
3	Same as step 1	80 mc	"80"	Same as step 1
4	Same as step 1	120 mc	"120"	Same as step 1
5	Same as step 1	160 mc	"160"	Same as step 1

* NOTE: Set "SPECTRUM WIDTH" knob (27, figure 5-1) to "1"; "BAND SELECTOR" switch (18, figure 5-1) to "10-150 MCS WIDE". Connect the Hewlett Packard Model 608 to the test point.

TABLE XII. SENSITIVITY CHECK FOR BAND 150-350 MEGACYCLES*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(2) (20, fig. 5-1)	140 mc	"140"	Less than 300 uv.
2	Same as step 1	200 mc	"200"	Same as step 1
3	Same as step 1	250 mc	"250"	Same as step 1
4	Same as step 1	300 mc	"300"	Same as step 1
5	Same as step 1	360 mc	"360"	Same as step 1

* NOTE: Set "SPECTRUM WIDTH" knob (27, figure 5-1) to "1"; "BAND SELECTOR" switch (18, figure 5-1) to "150-350 MCS". Connect the Hewlett Packard Model 608 to the test point.

TABLE XIII. SENSITIVITY CHECK FOR BAND 350-1000 MEGACYCLES*

STEP	TEST POINT	HEWLETT PACKARD MODEL 608 SETTING	TS-418	"TUNE" CONTROL SETTING	SIGNAL GENERATOR ATTENUATOR READING
1	(3) (17, fig. 5-1)	35 mc		"350"	Less than 600 uv.
2	Same as step 1	500 mc		"500"	Same as step 1
3	Same as step 1		650 mc	"650"	Same as step 1
4	Same as step 1		800 mc	"800"	Same as step 1
5	Same as step 1		1000 mc	"1000"	Same as step 1

* NOTE: Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "1"; BAND SELECTOR switch (18, figure 5-1) to "350-1000 MCS". Correct the Hewlett Packard Model 608 or TS-418 to the test point.

TABLE XIV. SENSITIVITY CHECK FOR BAND 1000-16000 MEGACYCLES*

STEP	SIGNAL GENERATOR	SIGNAL GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	***SIGNAL GENERATOR ATTENUATOR READING (dbm)
1	TS-419	950 mc	"1-2 KMCS"	"950	50
2	TS-419	1200 mc	"1-2 KMCS"	"1200"	50
3	TS-419	1500 mc	"1-2 KMCS"	"1500"	50
4	TS-419	1600 mc	"1-2 KMCS"	"1600"	50
5	TS-419	2100 mc	"1-2 KMCS"	"2100"	50
6	TS-419	1700 mc	"2-4 KMCS"	"1700"	50

NOTE:

* Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "25"; Connect the signal generator to test point (4) (19, figure 5-1).

** Polytechnic Research and Development Company.

***Maximum input level.

TABLE XIV. SENSITIVITY CHECK FOR BAND 1000-16000-MEGACYCLES* (cont)

STEP	SIGNAL GENERATOR	SIGNAL GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	***SIGNAL GENERATOR ATTENUATOR READING (dim)
7	TS-419	2100 mc	"2-4 KMCS"	"2100"	50
8	Hewlett Packard Model 616A	2600 mc	"2-4 KMCS"	"2600"	50
9	Hewlett Packard Model 616A	3200 mc	"2-4 KMCS"	"3200"	50
10	Hewlett Packard Model 616A	4000 mc	"2-4 KMCS"	"4000"	50
11	Hewlett Packard Model 616A	3400 mc	"4-8 KMCS"	"3400"	40
12	**PRD Model 902	4400 mc	"4-8 KMCS"	"4400"	40
13	**PRD Model 902	5500 mc	"4-8 KMCS"	"5500"	40
14	**PRD Model 902	6500 mc	"4-8 KMCS"	"6500"	40
15	**PRD Model 902	7000 mc	"4-8 KMCS"	"7000"	40
16	**PRD Model 902	6500 mc	"8-16 KMCS"	"6500"	40
17	Polarad Model MSG-4	7500 mc	"8-16 KMCS"	"7500"	40
18	Polarad Model MSG-4	8500 mc	"8-16 KMCS"	"8500"	40
19	Polarad Model MSG-4	9500 mc	"8-16 KMCS"	"9500"	40
20	Polarad Model MSG-4	10000 mc	"8-16 KMCS"	"10000"	40
21	Polarad Model SGX-12	12500 mc	"8-16 KMCS"	"12500"	40
22	Polarad Model SGX-12	13000 mc	"8-16 KMCS"	"13000"	40

NOTE: * Set the "SPECTRUM WIDTH" knob (27, figure 5-1) to "25"; Connect the signal generator to test point ④ (19, figure 5-1).
** Polytechnic Research and Development Company.
***Maximun input level.

TABLE XIV. SENSIBILITY CHECK FOR BAND 1000-16000 MEGACYCLES* (cont)

STEP	SIGNAL GENERATOR	SIGNAL GENERATOR SETTING	"BAND SELECTOR" SWITCH POSITION	"TUNE" CONTROL SETTING	***SIGNAL GENERATOR ATTENUATOR READING (dim)
23	Polarad Model SGX-12	13500 mc	"8-16 KMCS"	"13500"	40
24	Polarad Model SGX-12	14000 mc	"8-16 KMCS"	"14000"	40
25	Polarad Model SGX-12	14500 mc	"8-16 KMCS"	"14500"	40
26	Polarad Model SGX-12	15000 mc	"8-16 KMCS"	"15000"	40
27	Polarad Model SGX-12	15500 mc	"8-16 KMCS"	"15500"	40
28	Polarad Model SGX-12	16000 mc	"8-16 KMCS"	"16000"	40

TABLE XV. TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
B-supply voltage low	Low input power T1301 defective V1308, V1309, V1310 V1311, or V1312 defective	Check power source Replace Check for defective tube and replace
Analyzer does not operate in the "10-150 MCS NARROW" position. Operation is normal in all other positions.	Narrow band i-f amplifier V2201, V2202, V2203 and V2204 defective	Check for defective tube and replace
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer does not operate above 1000 mc. Operation is normal below 1000 mc.	Oscillator 4 defective	Replace cavity
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer does not opperate in the "350-1000 MCS" position. Operation is normal in all other positions.	Oscillator 3 defective	Replace cavity
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary.
Analyzer does not operate in the "150-350 MCS" position. Operation normal in all other positions	V2501 or V2502 defective	Check for defective tube and replace
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary
Analyzer does not operate in the "10-150 MCS NARROW" and the 10-150 MCS WIDE" positions. Operation is normal in all other positions.	V2503 or V2504 defective	Check for defective tube and replace
	Switch S2001 or switch S2201 defective	Clean contacts or replace switch as necessary

TABLE XV. TROUBLE SHOOTING CHART (cont)

TROUBLE	PROBABLE CAUSE	REMEDY
Analyzer operates normally in the "10-150 MCS NARROW" position, but does not operate in all other positions	Wide band amplifier V2201, V2202, V2203, or V2204 defective	Check for defective tube and replace
No output from the spectrum calibrator	V1401 defective	Replace
No vertical sweep on the scope screen. The video input from the 1-mc i-f is normal	V1304, V1305, or V1307 defective	Check for defective tube and replace
No horizontal sweep	V1301, V1302 or V1303 defective	Check for defective tube and replace
Pattern cannot be synchronized	V1301, V1302, or V1303 defective	Check for defective tube and replace
	Sweep frequency generator V1501, V1502, V1503, V1504 V1505, or V1506 defective	Check for defective tube and replace
Cannot control the brightness	KRT defective	Replace
	R1004 defective	Replace
	C1003 defective	Replace
No pattern on the scope screen	High voltage power supply defective	Replace
	KRT defective	Replace

graphs 6-1 through 6-17, to insure proper operation of the analyzer. If any of the minimum performance standards are not obtained, the associated subassembly must be replaced. Repairs to the individual subassemblies should not be attempted at this level of maintenance. Detailed maintenance of the individual subassemblies are covered in the latest issue of the Handbook of Overhaul Instructions.

6-21. VOLTAGE AND RESISTANCE MEASUREMENTS. Listed in tables XVI through XXV are voltage and resistance measurements for the spectrum analyzer. All measurements are made with a Simpson Model 260 Multitester from test point to ground. Any appreciable variation in voltage, and/or resistance from the specified values, indicates a probable malfunction. The causes for any such variation should be traced and repaired to insure proper operation of the spectrum analyzer.

WARNING

The high voltage employed in this equipment is dangerous to human life. Use extreme caution when making voltage checks. Maintenance personnel must at all times observe all safety precautions.

6-22. ALIGNMENT AND ADJUSTMENTS. The alignment and adjustment procedures for the spectrum analyzer are listed in paragraphs 6-1 through 6-17.

6-23. LUBRICATION. Lubrication is usually unnecessary. However, if excessive dirt or dryness might hinder the operation of the gear train assembly and lead screws, the following procedure should be performed.

a. Clean gear train assembly and lead screws with a typewriter brush.

b. Using Aeroshell Grease 7 (MIL-G-7118) on a clean fingertip, wipe the gear train assembly and lead screws lightly.

NOTE

All resistance measurements must be made with the equipment turned off, and with the tube removed from the socket being measured.

TABLE XVI. 1-MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
V1201	V	148	-6.4	0	6.3**	6.3**	148	0.1	0	0
	R	28K	47K	0.2	Heater	Heater	28K	10K	0	0
V1202	V	1.4	5.3	0	6.3**	148	131	0		
	R	330	1.1K	0	Heater	28K	35K	47K		
V1203	V	0	2.8	6.3**	0	148	148	2.8		
	R	51K	∞	Heater	0	28K	28K	930		
V1204	V	127	5.1	12	0	0	.7	12	12	6.3**
	R	38K	102K	2.8K	0	0	37K	510K	2.8K	Heater
V1205	V	-3.3*	0	0	6.3**	148	83	0		
	R	57K	0	0	Heater	38K	15K	0		
V1206	V	-2.6	0	0	6.3**	148	83	0		
	R	74K	0	0	Heater	38K	15K	0		
TP1201	V	0								
	R	470K								

NOTE: * Will vary with setting of R1229
**A-C volts

TABLE XVII. 64-MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7
V1101	V	50	-1	0	6.3**	.4	-1	50
	R		47	Heater	Heater	390		∞
V1102	V	-.1	.42*	6.3**	0	148	80	.42*
	R	330K	∞	Heater	0	∞	∞	51
V1103	V	0	6.3	6.3**	0	148	131	6.3
	R	330K	∞	Heater	0	∞	∞	10K*
V1104	V	0	4.9	6.3**	0	148	137	4.9
	R	330K	∞	Heater	0	∞	∞	4.7K
V1105	V	0	1.85	6.3**	0	148	103	1.85
	R	330K	∞	Heater	0	∞	∞	220

NOTE: * Will vary with setting R1112
**A-C volts.

TABLE XVIII. SWEEP FREQUENCY GENERATOR VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
V1501	V	-4.5	0	6.3**	0	136	143	0		
	R	47K	0	Heater	0	∞	∞	0		
V1502	V	135	-0.25	0	0	0	139	-0.27	0	6.3**
	R	∞	15K	.2	0	0	∞	22K	.2	Heater
V1503	V	0	0	6.3**	0	147	147	1.6		
	R	12K	0	Heater	0	∞	∞	120		
V1504	V	0	0	6.3**	147	147	147	1.7		
	R	2.7K	0	Heater	0	∞	∞	120		
V1505	V	-1.5	1.5	6.3**	0	147	88	1.4		
	R	5.1K	∞	Heater	0	∞	∞	51		
V1506	V	-3.5	0	6.3**	0	147	140	0		
	R	10K	0	Heater	0	∞	∞	0		
TP1501*	V	1.8								
	R	100K								
TP1502*	V	0.7								
	R	87K								
TP1503*	V	0.3								
	R	47K								
TP1504	V	0								
	R	0								
TP1505	V	0								
	R	0								
TP1506	V	-3.5								
	R	10K								

NOTE: * Diode involved
**A-C volts

TABLE XIX. POWER SUPPLY AND VIDEO VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
V1301	V	31	-138	-142	6.3**	6.3**	150	-170	-142	0
	R	8.5K	510K	48K	100	100	82K	3MEG	48K	∞
V1302	V	-90	-170	-150	6.3**	6.3**	15	-140	-135	0
	R	2.5MEG	2.5MEG	48K	100	100	100K	62K	51K	∞
V1303	V	77	-140	-137	6.3**	6.3**	-28.5	-137	-137	0
	R	530K	52K	70K	100	100	53K	70K	68K	∞
V1304	V	115	0	1.25	6.3**	6.3**	0	0	0	0
	R	85K	0	510	100	100	0	0	0	∞
V1305	V	95	-120	-125	6.3**	6.3**	-115	-127	-125	0
	R	290K	1.1MEG	63K	100	100	290K	70K	63K	∞
V1306	V	-0.35	0	6.3**	0	147	30	0		
	R	2.2MEG	0	100	100	75K	530K	0		
V1307	V	-144	-144	-120	6.3**	6.3**	110	0	1.9	0
	R	50K	50K	1.1MEG	100	100	75K	1MEG	220	∞
V1308	V	-32	77	0	107	260	150	0	6.3**	
	R	1MEG	50K	0	1MEG	75K	75K	100	100	
V1309	V	-32	-65	-65	6.3**	6.3**	-65	-87	-87	0
	R	1MEG	560K	33K	100	100	560K	84K	40K	∞
V1310	V	0	0	0	-87	0	0	0		
	R	0	∞	∞	40K	∞	∞	∞	∞	
V1311	V	107	260	150	107	260	150	0	6.3**	
	R	1MEG	78K	70K	1MEG	75K	70K	100	100	
V1312	V	110	52	52	6.3**	6.3**	52	-0.35	0	0
	R	1.1MEG	120K	300K	100	100	300K	110K	0	∞
TP1301	V	150								
	R	70K								
TP1302	V	-150								
	R	48K								

NOTE: * All front panel controls are fully counterclockwise
**A-C volts

TABLE XX. SPECTRUM CALIBRATOR AND KRT VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9	10	11	14
V1401	V	150	-1.15*	1.05*	0	0	150	-2.0*	1.05*	6**			
	R	∞	10K	110	0	0	∞	10K	110	∞			
V1001	V												
	R	3.5MEG	3.5MEG	5MEG		3.5MEG		∞	∞	∞	∞	∞	∞

NOTE: * Will vary with setting of "FREQUENCY" knob
**A-C volts

TABLE XXI. HIGH VOLTAGE SUPPLY VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
TP1601	V	158								
	R	5MEG								
TP1602	V	-160								
	R	5MEG								

TABLE XXII. OSCILLATORS 1 AND 2 VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL		PIN NUMBERS 1	2	3	4	5	6	7	8	9
V2501	V									
	R	∞	8820	0	0	620	8820	∞		
V2502	V									
	R	∞	0	0	0	441	0	∞		
V2503	V									
	R	∞	47K	0	0	0	∞	47K	0	0
V2504	V									
	R	∞	0	0	0	150	0	∞		

TABLE XXIII. 160-MC I-F AMPLIFIER VOLTAGE AND RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL	PIN NUMBERS 1	2	3	4	5	6	7
V2201** V	0	0.4	6*	0	147	75	0.4
R	0	∞	0.6	0	∞	∞	∞
V2202** V	0	1.3	6*	0	137	100	1.3
R	0	∞	0.6	0	∞	∞	∞
V2203** V	0	1.3	6*	0	133	105	1.3
R	0	∞	0.6	0	∞	∞	∞
V2204** V	0	1.3	6*	0	137	107	1.3
R	0	∞	0.6	0	∞	∞	∞
V2205** V	0	1.5	6*	0	145	115	1.5
R	0	100	0.6	0	∞	∞	100
V2206** V	0	1.5	6*	0	120	115	1.5
R	0	100	0.6	0	∞	∞	100
V2207** V	0	0.95	6*	0	150	115	0.95
R	0	68	0.6	0	∞	∞	68
V2208** V	0	0.5	6*	0	150	70	0.5
R	51	∞	0.6	0	∞	∞	∞
V2209*** V	0	4.0	6*	0	150	125	4.0
R	0	∞	0.6	0	∞	∞	∞
V2210*** V	0	4.0	6*	0	145	130	4.0
R	0	∞	0.6	0	∞	∞	∞

NOTE: * A-C volts
**Range Selector switch in any position except the "10-150 MCS NARROW" position
***Range Selector switch in the "10-150 MCS NARROW" position

TABLE XXIV. CONNECTORS, RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL	LOCATION	PIN NUMBERS A 1	B 2	C 3	D 4	E 5	F 6	G 7	H 8	I 9	J 10	K 11	L 12	M 13	N 14	O 15
J1001	Indicator Drawer	∞			0	∞		∞	∞		∞	∞	∞			
J1002	Indicator Drawer	∞		∞	0	∞		200K		∞	80K	∞		∞	∞	∞
J1004	Indicator Drawer				0			200K			80K			∞	∞	
J1005	Indicator Drawer				0			200K						∞	∞	
J1006	Indicator Drawer				0			200K						∞		∞
J1008	Indicator Drawer				0			200K			70K			∞		∞
J1003	Indicator Drawer		0	∞	80K	∞	200K		∞							
P1005	Indicator Drawer	0	∞	∞												
J1601	High Voltage Supply	0	∞	∞												
J1602	High Voltage Supply	∞														
J1603	High Voltage Supply	∞														
J1604	High Voltage Supply	7MEG														
P1601	High Voltage Supply	6MEG														
P1201	1-MC I-F Amplifier				0			28K			350K			0	HTR	
P1102	64-MC I-F Amplifier				0			∞						0	HTR	
P1502	Sweep Freq. Generator				0			∞			1MEG			0		HTR
P1301	Power Supply & Video	∞		∞	0	100		70K		100	48K	100		100	100	100

TABLE XXIV. CONNECTORS, RESISTANCE MEASUREMENTS (cont)

CIRCUIT SYMBOL	LOCATION	PIN NUMBERS A 1	B 2	C 3	D 4	E 5	F 6	G 7	H 8	I 9	J 10	K 11	L 12	M 13	N 14	O 15
P1302	Power Supply & Video	530K	530K		0	32K		70K	70K		48K	290K	290K			
P2201	160-MC I-F Amplifier	∞		∞	0	∞		∞		∞		∞		∞	HTR	
P1401	Spectrum Calibrator				0			∞		∞		∞		0		∞
J1401	Spectrum Calibrator	1358														
J2011	R-F Tuner Drawer	∞	0	0	∞	0	∞		0							
J2501	Oscillators 1 and 2	∞	0	0	∞	0	∞		∞							
J2504	Oscillators 1 and 2	∞														
J2505	Oscillators 1 and 2	∞														
J2503	Oscillators 1 and 2	∞														

TABLE XXV. 160-MC I-F AMPLIFIER INPUT JACKS, RESISTANCE MEASUREMENTS

CIRCUIT SYMBOL	* SWITCH S2201 POSITIONS 1	2	3	4	5	6	7	8
J2201	∞	∞	∞	∞	∞	∞	0	∞
J2202	∞	∞	∞	∞	∞	0	∞	∞
J2203	∞	∞	∞	∞	0	∞	∞	∞
J2205	0	0	0	0	∞	∞	∞	∞

NOTE * Starting with position 1 as the maximum counterclockwise position

SECTION VII

DIAGRAMS

7-1. GENERAL. The following diagrams are used for maintenance of the spectrum analyzer. The figure number and title of each are contained in the list of illustrations.

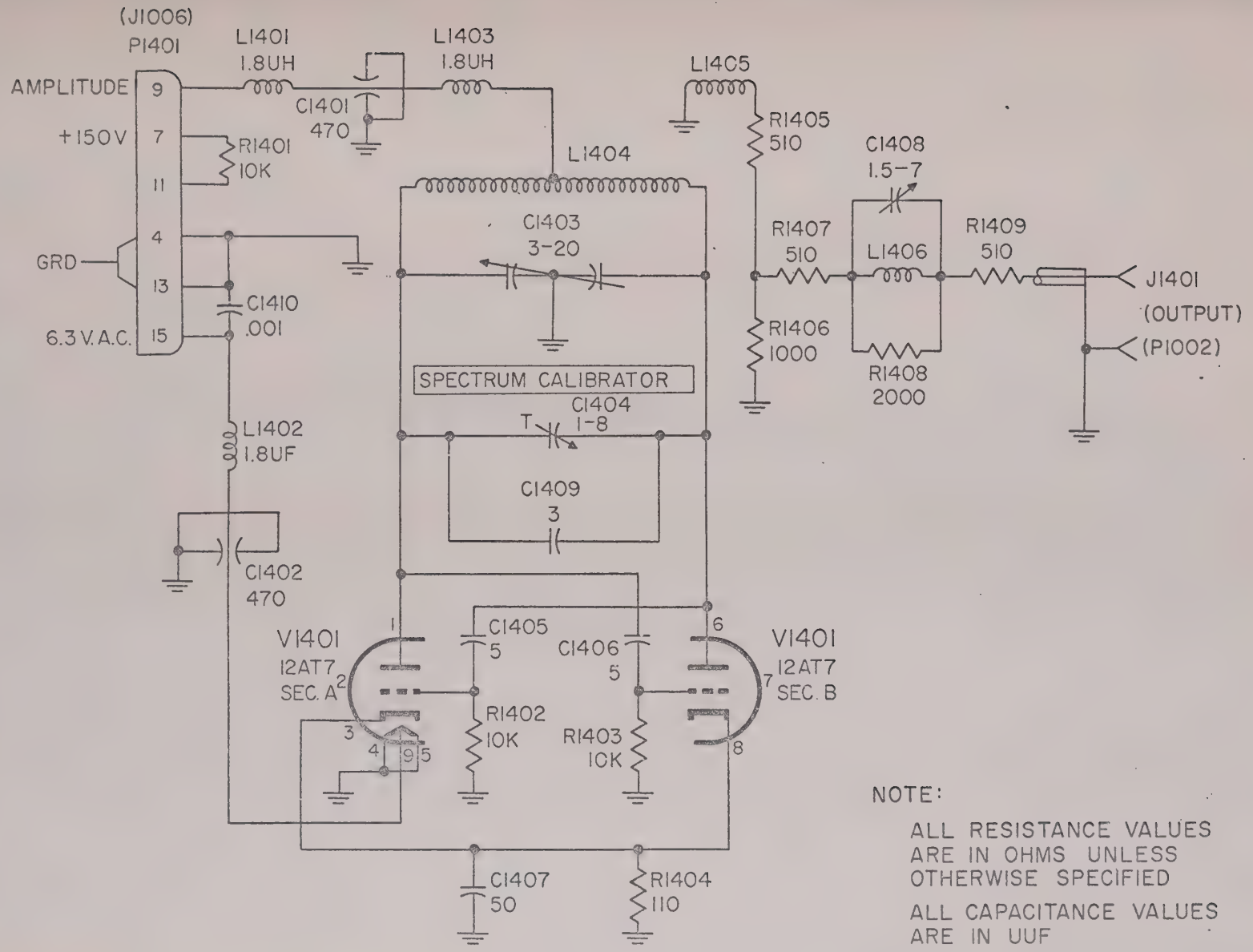
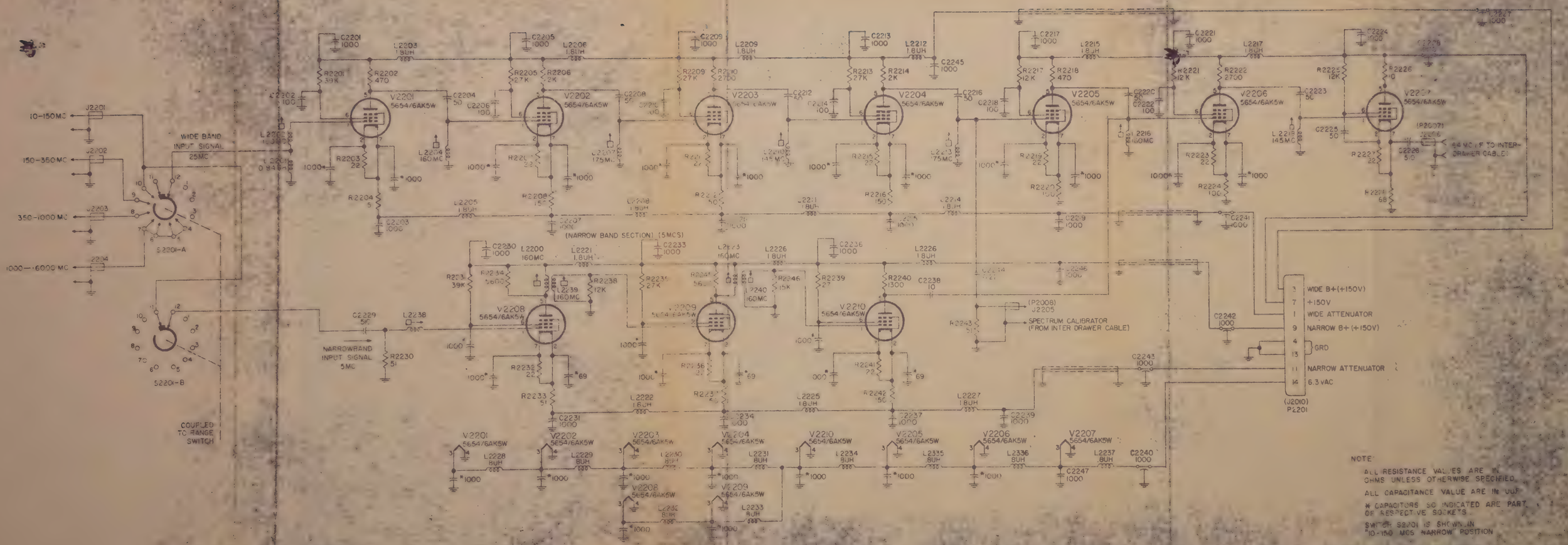


Figure 7-2. Spectrum Calibrator, Schematic Diagram



NOTE

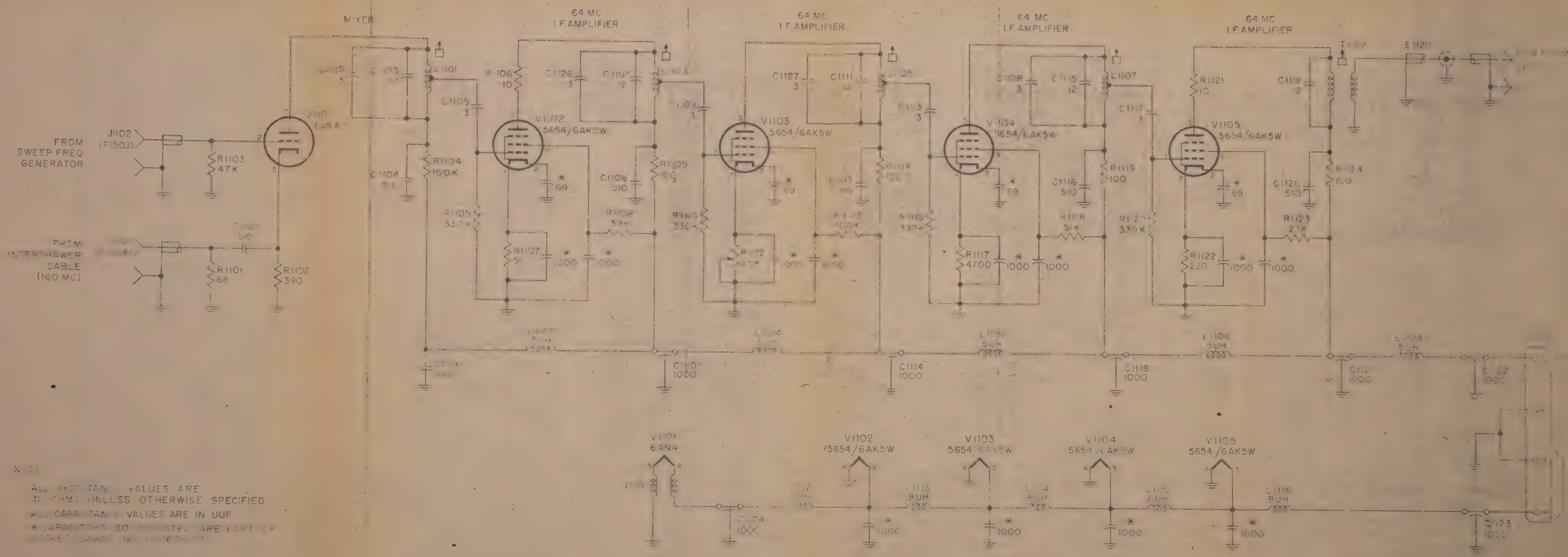
ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.

ALL CAPACITANCE VALUE ARE IN UUF.

* CAPACITORS SO INDICATED ARE PART OF RESPECTIVE SOCKETS.

SWITCH S2201 IS SHOWN IN "10-150 MCS NARROW" POSITION

Figure 2-1. 160 MC I-F Amplifier Schematic Diagram


MIXER
64 MC I.F. AMPLIFIER
64 MC I.F. AMPLIFIER
64 MC I.F. AMPLIFIER
64 MC I.F. AMPLIFIER
FROM SWEEP FREQ GENERATOR
J1102 (P1503)
R1103 47K
R1104 100K
C1104 5.0
C1105 3
C1106 510
C1107 5
R1105 33K
R1107 51
R1108 39
R1109 100
R1110 330
C1110 1000
C1111 12
C1112 510
R1112 100K
R1113 330
C1114 1000
C1115 12
C1116 510
R1117 4700
R1118 51K
R1119 100
C1118 1000
C1119 12
C1120 510
R1121 10
R1122 220
R1123 27K
R1124 100
C1123 1000
V1101 6AN4
V1102 5654/6AK5W
V1103 5654/6AK5W
V1104 5654/6AK5W
V1105 5654/6AK5W
L1101
L1102
L1103 .8UH
L1104 .8UH
L1105 .8UH
L1106 .8UH
L1107
L1108
L1109 .8UH
L1110 .8UH
L1111 .8UH
L1112 .8UH
L1113 .8UH
L1114 .8UH
L1115 .8UH
L1116 .8UH
T1102
E1120
FROM INTERTOWER CABLE (160 MC)
R1101 68
R1102 390
C1102 5.0
C1103 10
C1108 3
C1109 3
C1113 3
C1121 3
C1122 3
C1124 1000
C1125 3
C1126 3
C1127 3
C1128 1000
C1129 .5UH
C1130 1000
C1131 1000
C1132 1000
C1133 1000
C1134 1000
C1135 1000
C1136 1000
C1137 1000
C1138 1000
C1139 1000
C1140 1000
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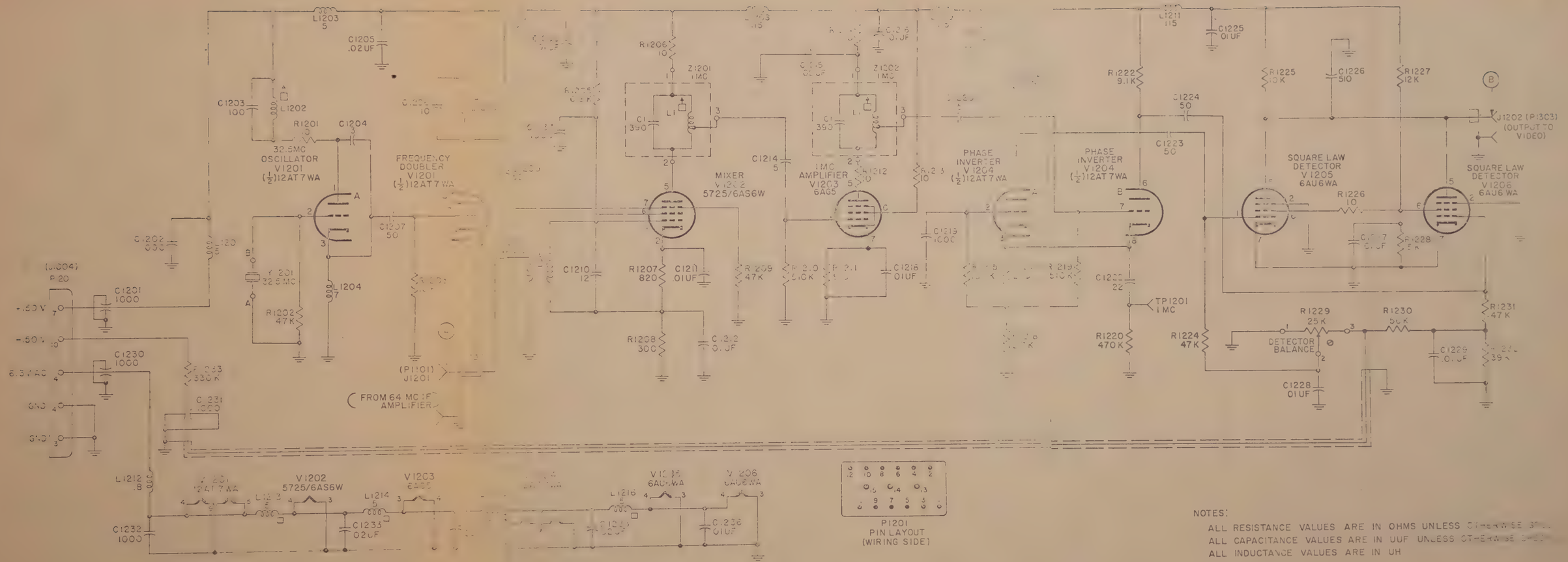
C1147 1000
C1148 1000
C1149 1000



NOTES:

ALL RESISTANCE VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
ALL CAPACITANCE VALUES ARE IN UUF UNLESS OTHERWISE SPECIFIED.
ALL INDUCTANCE VALUES ARE IN UH

Figure 7-4. 1MC I-F Amplifier - Schematic Diagram

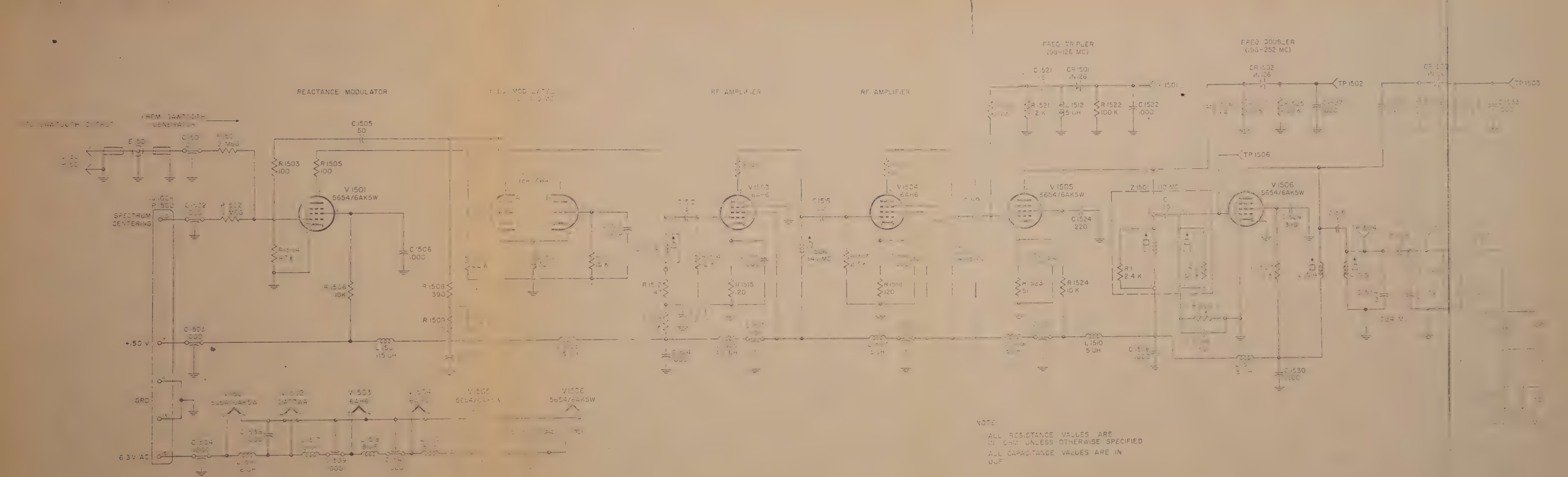


Figure 7-5. Sweep Frequency Generator, Schematic Diagram

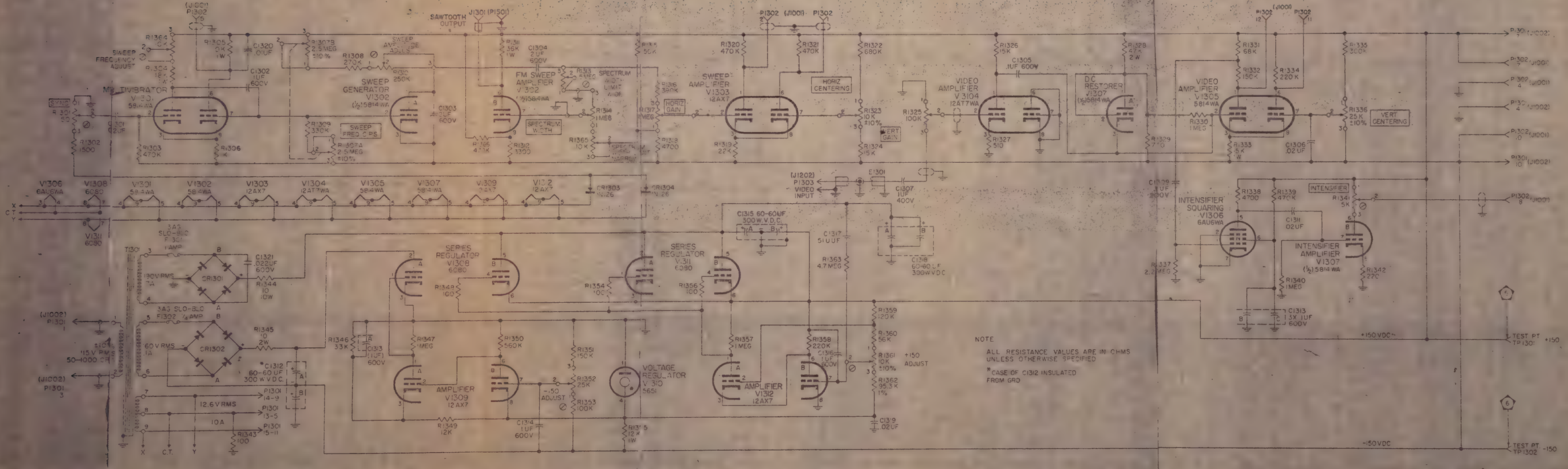


Figure 7-6. Power Supply and Video, Schematic Diagram

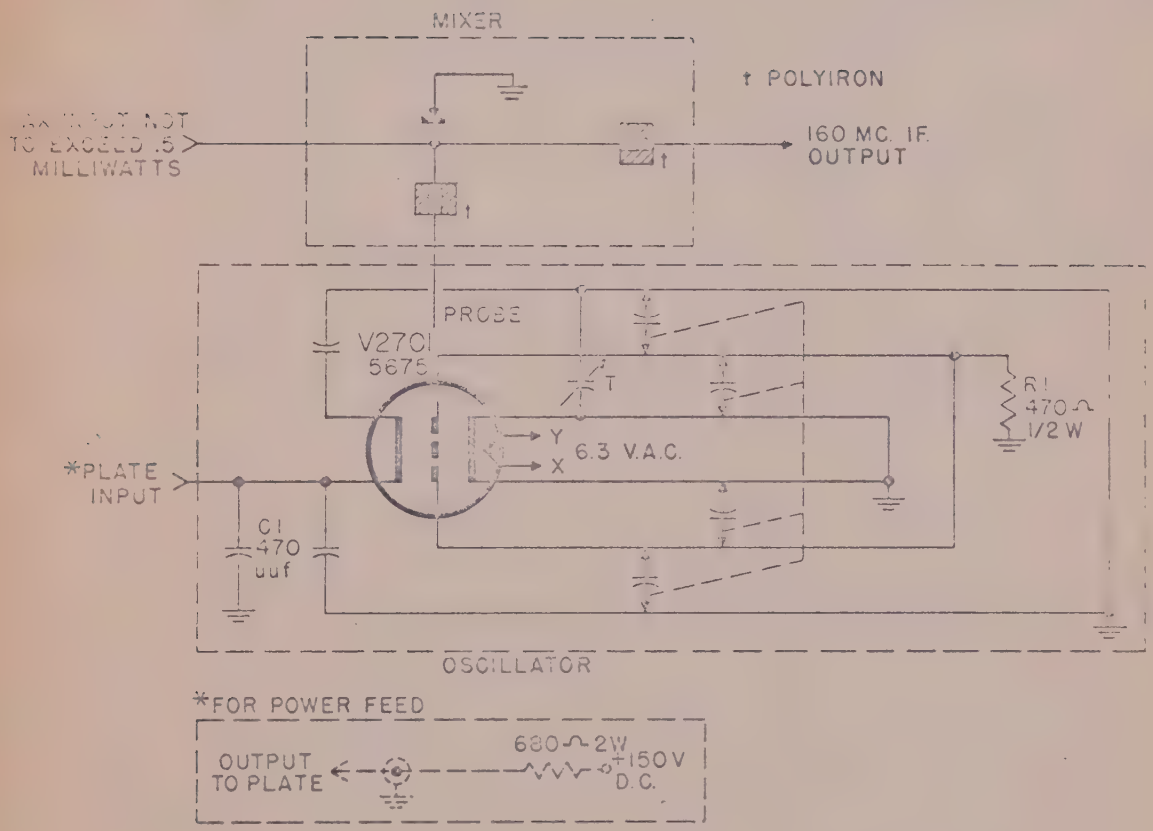


Figure 7-7. Oscillator 3, Schematic Diagram

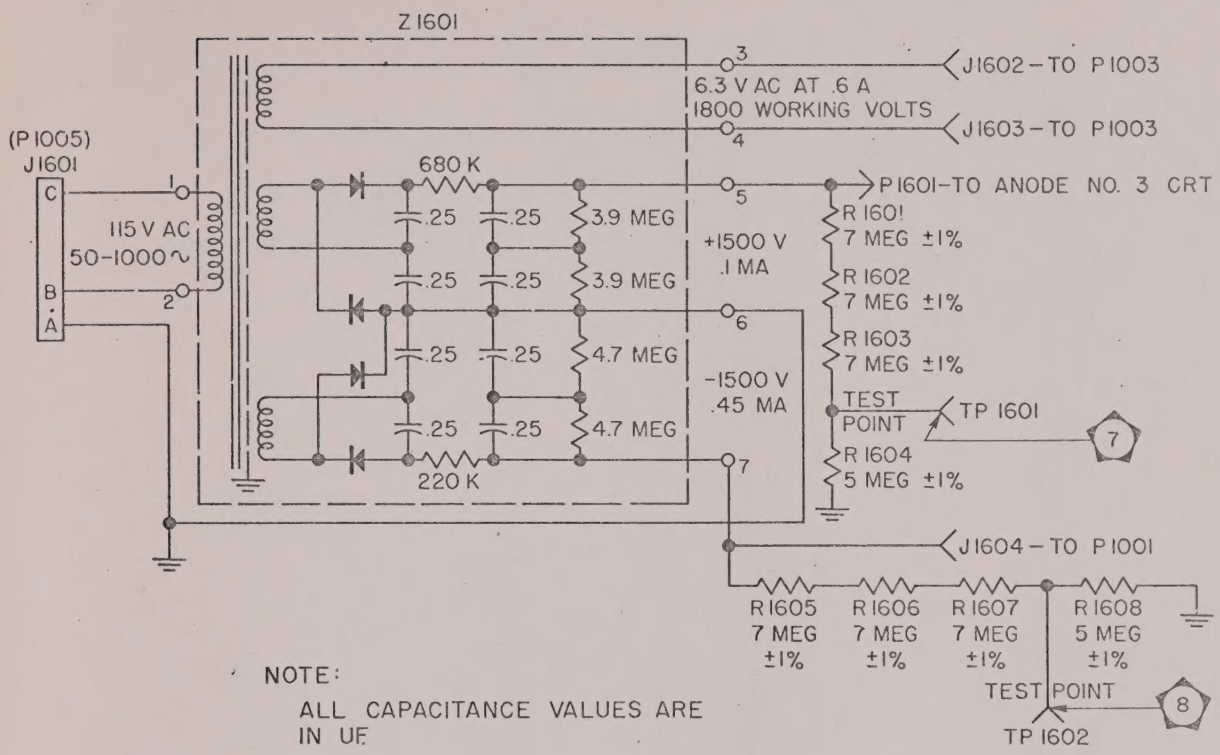


Figure 7-8. High Voltage Supply, Schematic Diagram